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INVESTIGATION OF FACILITY REQUIREMENTS FOR THE TEST AND EVALUATION OF SHIPBOARD NUCLEAR WEAPON SECURITY SYSTEMS

BY R. D. JOHNSON T. V. PEACOCK

COMBAT SYSTEMS DEPARTMENT

15 APRIL 1981

NAVAL SURFACE WEAPONS CENTER

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A study was conducted to investigate the suitability of existing facilities to support operational environmental testing of nuclear weapons security systems prior to shipboard deployment of the systems. In this context, security systems are comprised of hardware components, operational procedures, and security force personnel. The desired functional objectives of the facility are: (1) provide test and evaluation capabilities for shipboard security systems; (2) provide the capability to perform realistic

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intruder penetration trials; and (3) provide the capability to develop and validate security system operational procedures.

The investigation included an analysis to determine operational environmental testing requirements applicable to shipboard security systems; a survey of existing test facilities to identify capabilities and availabilities; and an analysis of military construction programming options in the event construction of a new facility is necessary.

Principal simulation capabilities required of the facility involve shipboard operational factors which significantly affect the operability and reliability of security systems. These factors are: shipboard compartments and weather deck areas; shipboard equipment and interface characteristics; and shipboards environmental effects. No suitable existing facility was identified that could support this range of operational environmental testing.

FOREWORD

The results of a study which investigated the suitability of existing facilities to support operational environmental testing of shipboard nuclear weapons security systems are presented.

The work reported herein was funded by the Naval Sea Systems Command under the technical direction of the Naval Surface Weapons Center.

The authors gratefully acknowledge the timely and thorough assistance provided by B. B. Barger in researching and preparing the data base for the Military Construction Programming analysis section. The contributions of G. P. Worrel and W. W. Mebane were of particular significance in establishing facility requirements with respect to the identification of shipboard compartments and environmental testing criteria. Appreciation is also extended to T. G. Bennett for his thorough research in support of the facility survey, and to the Technology Assessment and Requirements Analysis team members for their inputs to the requirements definitions.

John H. Malloy
JOHN H. MALLOY
By direction

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SECTION 1 INTRODUCTION

1.1 The Naval Surface Weapons Center (NSWC), under sponsorship of NAVSEA 643, is the technical agent for the Navy's Shipboard Nuclear Weapon Security (SNWS) Program. The work breakdown structure for the SNWS Program is presented in Figure 1. The primary program objective is the production of an operationally effective and suitable nuclear weapons security system for shipboard installation. The system must detect unauthorized intruders and prevent their access to nuclear weapons.

1.2 The program objective encompasses the development, test, and evaluation of technologies for the physical security of nuclear weapons aboard ship. Areas of investigation will include intrusion sensors, identification devices, barriers, security of storage, displays, command and control, fire control and weapon launchers, non-lethal response devices, and line security. These technology areas must be examined for suitability and ability to function in a shipboard environment against the shipboard threats.

1.3 In achieving this program objective, the following approaches will be taken:

1.3.1 Maximum utilization of the technological advances in: (1) intrusion sensor technology developed during and after the Vietnam conflict; (2) command and control display technology using state-of-the-art microprocessor, mini-computer, and display techniques to provide more efficient security system-man interfaces; and (3) microprocessor technology permitting the relatively inexpensive line security techniques such as pseudo-random interrogation and coding.

1.3.2 Consideration of the behavioral characteristics of the intruder and security forces.

1.3.3 Reduction in cost by commonality, where feasible, with developments of the related Army and Air Force efforts.

1.3.4 Reduction in costs by installation commonality. The use of modular systems will be carefully examined.

1.3.5 Low life-cycle cost.

1.3.6 Examination of nuclear weapons security in the broader concept of total ship physical security.

1.3.7 Analysis of the nuclear weapons security problem and potential solutions from a total systems standpoint.

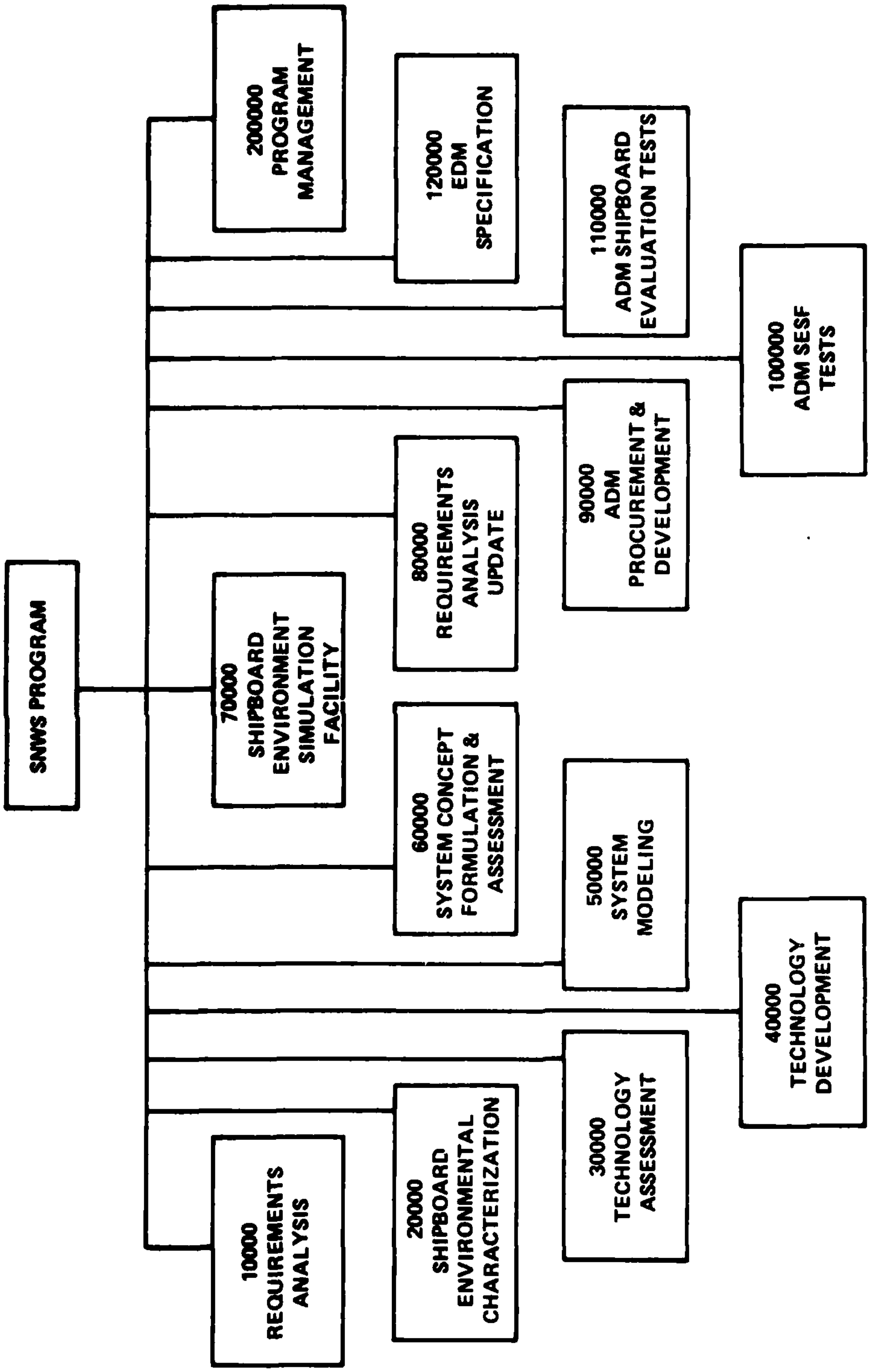

FIGURE 1 SHIPBOARD NUCLEAR WEAPON SECURITY (SNWS) PROGRAM SUMMARY WORK BREAKDOWN STRUCTURE

1.3.8 Relative independence of the system from the human element and reduction of the manning requirement necessary to meet a particular threat.

1.4 It is necessary to vigorously validate each aspect of a security system throughout its development to ensure deployment of an effective and suitable system. This test and evaluation phase precedes shipboard operational testing. However, the utilization of a ship, or ships, for realistic test and evaluation of security systems is impractical due to the following considerations which impact program cost, schedule and technical validity:

1.4.1 A single ship class does not represent the totality of environments which will be encountered by security systems.

1.4.2 Multiple-ship testing requires considerable duplication of hardware for parallel testing, or requires an extended time period if each of several ship classes are tested sequentially.

1.4.3 Most shipboard environmental conditions are integral with ships operations and cannot be controlled or isolated to the extent necessary for quantitative test and evaluation.

1.4.4 Dedicated fleet assists are difficult to obtain, and are very expensive to fund from R&D budgets.

1.4.5 Fleet support on a not-to-interfere basis is less expensive than a dedicated ship, but would considerably prolong test duration due to the lack of test parameter control; comprehensive operational scenarios are necessary to properly support developmental testing programs.

1.5 As an alternative to shipboard developmental testing, a land-based environmental simulation laboratory or facility offers a technically valid and cost-effective approach for supporting technology development and for providing the means to verify component and system performance prior to Advanced Development Model (ADM) and Operational Evaluation testing. Such testing will: (1) eliminate potential problem areas; (2) provide a basis for shipboard test planning; and (3) establish the requirements and recommendations for future design and testing of individual components or systems on a continuous basis. The proposed facility will have the following general functional objectives:

1.5.1 Technical functional objective: provide test and evaluation capabilities for shipboard security systems.

1.5.2 Operational functional objectives:

1.5.2.1 Provide the capability to perform realistic intruder penetration trials.

1.5.2.2 Provide the capability to develop and validate security system operational procedures.

1.6 Under the SNWS Program management structure presented in Figure 1, the Shipboard Environmental Simulation Facility (SESF) task area was established to identify and provide the test and evaluation capabilities required for shipboard nuclear weapons security systems. The initial effort of the task area consisted

of an investigative phase to develop a recommended course of action for the task area objective. This report presents the approach taken, the results and the conclusions of that investigation.

SECTION 2 APPROACH

2.1 An investigation was conducted to determine the most practical approach for providing the simulation facility capabilities required for the SNWS Program. Based on the functional objectives of paragraph 1.5, these facility capabilities are:

2.1.1 Provide a means of testing security systems which incorporate sensors which could operate on a wide range of sensing mechanisms.

2.1.2 Be capable of simulating shipboard environments which are likely to affect the operation of a security system.

2.1.3 Provide a means to measure the performance parameters of security systems so the relative merit of competing security concepts can be determined.

2.1.4 Provide a means to simulate the electrical and mechanical interfaces of the security systems with other shipboard systems.

2.1.5 Provide the human to security system shipboard interfaces.

2.1.6 Provide a means to perform realistic aggressor penetration trials and agressor/response force detection and engagement exercises.

2.1.7 Provide supporting data for computer modeling of security systems.

2.1.8 Provide support for the development and the evaluation of the security system operational tactics, procedures and technical documentation.

2.2 The conclusions and recommended course of action presented in this report for meeting the facility objectives were derived from results of the following investigative areas:

2.2.1 Technical Requirements Definition. The initial phase identified the requirements and characteristics of a simulation facility for evaluating shipboard nuclear weapons security systems. This included the following factors which might affect the operability and reliability of sensor systems: environmental parameters; configurational features of shipboard spaces; and interface characteristics pertinent to those spaces.

2.2.2 Existing Facility Survey. A survey was conducted to determine if existing facilities were available that could provide the required technical capabilities. Government technical facilities registers, which included private industry sources that support government testing activities, were researched to compare compatibilities with SNWS Program technical requirements. Based on the facility registers research results, visits were made to various activities which appeared to offer significant pertinent capabilities.

2.2.3 Military Construction (MILCON) Programming Analysis. Since it was subsequently determined that no existing facility could meet SNWS Program requirements, it was necessary to conduct an analysis of military construction programming in order to assess the impact of MILCON requirements on the projected facility availability date.

SECTION 3 RESULTS

3.1 FACILITY TECHNICAL REQUIREMENTS. The technical requirements and capabilities of an environmental simulation facility for shipboard nuclear weapons security systems are determined by scenario-dependent factors which affect the operability and reliability of sensor systems. These include shipboard operational environmental factors, configurational feature of pertinent shipboard spaces, and interface characteristics associated with those spaces.

3.1.1 Environmental Conditions.

3.1.1.1 These are prevailing natural or man-made shipboard conditions that affect equipment performance via both direct and interactive effects of electrical, mechanical, acoustical, electromagnetic, corrosive and weathering phenomena. The complete set of environmental criteria to be met by equipment intended for Navy use is established during its development, and necessarily varies according to the function and location of the equipment under consideration. The ability to survive and operate under the extremes of the various shipboard environments is a necessity for equipment to be installed aboard ships. Survivability is the ability of the system to survive exposure to the environment without permanent damage. Operability is the ability of the system to perform its intended function without undesirable responses while exposed to the electromagnetic environment. This characteristic is especially important in the specific case of security systems, since the nominal shipboard operating environments encountered by such systems must not contribute to excessive false alarm rates, while simultaneously allowing acceptable sensing threshold levels.

3.1.1.2 Since the function of the SESF is the testing of shipboard nuclear weapons security equipment, it is unnecessary that this facility incorporate testing capabilities for the complete spectrum of naval environmental conditions. For example, some environmental criteria for Navy equipment apply only to aircraft or shore-based installations and are not necessarily applicable to shipboard deployment. Accordingly, Table 1 lists a broad spectrum of environments which

Table 1. SHIPBOARD ENVIRONMENTAL PARAMETERS AND SPECIFICATIONS

	Applicability to Shipboard Spaces(1)		
	Interior	Exterior	Both
1. Vibration			d & e
2. Shock			d & f
3. Acceleration			c
4. Temperature	c & d	c & d	
5. Humidity			c & d
6. Salt Fog		c & d	
7. EMI Susceptibility: Conducted Radiated	c, g, h & i	c, g, h & i	
8. Acoustics Susceptibility	k	k	
9. Magnetic Field Susceptability			Note (2)
10. Barometric Pressure			l
11. Volt & Frequency Steady-State Transient			 a & d a & d
12. Spike Voltage			a & d
13. Power Interruption			a & d
14. Accelerated Life			a & d
15. Ionizing Radiation Susceptibility	TBD(3)	TBD	
16. Rain		c	
17. Icing		d	
18. Wind		b & d	
19. Solar Radiation		c & d	

Table 1. (Cont.)

	Applicability to Shipboard Spaces[1]		
	Interior	Exterior	Both
20. Atmospheric Pollutants		TBD	
21. Gun Blast		b & d	
22. Missile Exhaust		b	
23. Nuclear Air Blast		d	
24. Hydrostatic Pressure		d	
25. Underwater Explosion			d
26. Structural Integrity			d
27. Enclosure	d & j	d & j	
28. Inclination			d
29. Ship Motion			b
30. Electromagnetic Pulse	TBD	TBD	

Notes:

(1) If testing standards apply the same for both interior and exterior ship location, then the "both" column is used; if different, then the interior and/or exterior column is used as appropriate. The numbers in the matrix elements refer to the following specification reference documents:

a. DoD-STD-1399 (Navy): Interface Standard for Shipboard Systems Section 300 (8/1/78): Electric Power, Alternating Current (Metric)

b. MIL-STD-1399B (Navy) (11/22/77): Interface Standard for Shipboard Systems

Section 072-Part 1 (10/14/77): Blast Environment, Missile Exhaust
Section 072.2 (12/1/76): Blast Environment, Gun Muzzle
Section 204 (5/20/74): Ambient Air Conditions in Surface Ship Compartments
Section 301 (2/17/72): Ship Motion & Attitude
Section 302 (2/20/72): Weather Environment
Section 401 (1/11/71): D.C. Magnetic Field Environment

Table 1. (Cont.)

Notes:

c. MIL-STD-810C (3/10/75): Environmental Test Methods

Method No.	501.1	High Temperature
	502.1	Low Temperature
	505.1	Solar Radiation
	506.1	Rain
	507.1	Humidity
	509.1	Salt Fog
	513.2	Acceleration

d. MIL-E-16400G (Navy) Amendment 1 (12/1/76): Electronic, Interior Communication and Navigation Equipment, Naval Ship & Shore: General Specification for

e. MIL-STD-167-1 (Ships) (5/1/74): Mechanical Vibrations of Shipboard Equipment (Type I - Environmental & Type II - Internally Excited)

f. MIL-S-901C (Navy) (1/15/63): Shock Tests, H.I. (High-Impact): Shipboard Machinery, Equipment & Systems; Requirements for

g. MIL-STD-461A (7/3/73): Electromagnetic Interference Characteristics: Requirements for Equipment

h. MIL-STD-462 (5/1/70): Electromagnetic Interference Characteristics: Measurement of

i. MIL-HDBK-235, Parts 1, 2, and 3: Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment

j. MIL-STD-108E (8/4/66): Definitions of & Basic Requirements for Enclosures for Electric & Electronic Equipment

k. MIL-STD-740B (SHIPS) (6/22/65): Airborne and Structureborne Noise Measurements and Acceptance Criteria.

l. MIL-STD-210B (12/15/73): Climatic Extremes for Military Equipment

(2) Stray magnetic fields (60 Hz to 400 Hz) induced by ships power sources or electric motors. Specific testing levels and procedures to be determined.

(3) TBD ≡ To Be Determined

are generally applicable to shipboard equipment. This listing and associated environmental criteria were generated from References 1 through 9.

3.1.1.3 Table 1 includes the four environments which have been identified by the Technology Assessment Task Area (Work Breakdown Structure No. 30000 of Figure 1) as being critical requirements of a SESF. The environments are: vibration, acoustics, thermal effects, and electromagnetic radiation. They are extremely important because security systems may operate on these influences. Consequently, a security system may be susceptable to performance anomalies (such as false alarms or detection insensitivities) depending on the prevailing shipboard signal-to-noise characteristics associated with these environments. The SESF must be capable of supporting tests to exercise these environments within parametric limits comparable to those encountered aboard ship. However, the identification of these four environments does not imply that any of the other environments is to be necessarily excluded from the facility capabilities. Rather, inclusion or exclusion should be based on individual cost versus benefit trade-off studies which are beyond the scope of this report.

3.1.1.4 The various specifications of Table 1 encompass the "survivability" extremes of various shipboard environmental parameters. However, detailed characterizations of the nominal shipboard "operational" conditions (such as vibration time histories involving amplitude, phase and frequency data), which might affect sensor system performance, are essentially lacking. Included in this latter category are the environmental effects introduced by shipboard equipment and interface characteristics such as various pneumatic devices, ventilating system, etc. (see paragraph 3.1.2.2). This general conclusion was based on

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[1] Interface Standard for Shipboard Systems; Section 300 (8/1/78): Electric Power, Alternating Current (Metric), DoD-STD-1399 (Navy).

[2] Interface Standard for Shipboard Systems, MIL-STD-1399B (Navy) (11/22/77).

[3] Environmental Test Methods, MIL-STD-810C (3/10/75).

[4] Electronic, Interior Communication and Navigation Equipment, Naval Ship & Shore: General Specification for, MIL-E-16400G (Navy) Amendment 1 (12/1/76).

[5] Mechanical Vibration of Shipboard Equipment (Type I - Environmental & Type II - Internally Excited), MIL-STD-167-1 (Ships) (5/1/74).

[6] Shock Tests, H. I. (High-Impact); Shipboard Machinery, Equipment & Systems; Requirements for, MIL-S-901C (Navy) (1/15/63).

[7] Electromagnetic Interference Characteristics; Requirements for Equipment, MIL-STD-461A (7/3/73).

[8] Electromagnetic Interference Characteristics; Measurement of, MIL-STD-462 (5/1/70).

[9] Definitions of & Basic Requirements for Enclosures for Electric & Electronic Equipment, MIL-STD-108E (8/4/66).

the results of a survey (Reference 10) conducted by NSWC Code E21 for the SNWS Project Office. The purpose of the survey was to determine the existence of data that could be used to characterize those shipboard environments that might affect the survivability and operability environmental characteristics. In spaces where the environment is controlled, the operability range is to some extent less than the survivability range. Conversely, there are environmental parameters that have such significant ambient operating characteristics that some sensor thresholds would frequently be exceeded; in these instances where a particular environment is an inherent characteristic of a shipboard location (such as shock, vibration and acoustics from aircraft launch catapults), then a candidate security system would not likely to be selected which would have functional elements sensitive to such an environment.

3.1.1.5 Consequently, specific criteria to be incorporated in the SESF cannot be identified at this time because the environmental levels are insufficiently characterized in those spaces of interest to the SNWS Program. Such specifications will be deferred until the Shipboard Environmental Characterization (SEC) task area (Work Breakdown Structure No. 20000 of Figure 1) conducts a shipboard measurements program in FY80. This program will measure and characterize those environmental parameters where insufficient data exists to support program requirements. Despite the lack of empirical shipboard operational environmental characterization data, general SESF requirements have been established based on limited existing data. Thus for interim use, Table 2 presents general parametric characteristics for the four critical environments of electromagnetic radiation, vibration, acoustics and temperature.

3.1.1.6 Even though the existing environmental data cannot be separated into absolute categories of survivability and operability, the survey reviewed each set of data for comparison with criteria appropriate for existing sensor systems and associated technologies. The following information was synopsized from that report:

a. Shipboard Environment Survivability Criteria. The data considered appropriate for survivability limits in the areas related to shipboard installation are presented as "Environmental Criteria" in Table 3. These criteria represent maximum expected levels of the environments; they support design factors, such as selection of design and construction features, necessary for equipment survival from manufacture to use.

b. Shipboard Temperature (including infrared environment). Very little temperature data are available that are suitable for establishing survivability criteria, thus such extremes were derived from existing climatic extremes specifications. No data were found that are suitable for assessing operability. Details follow:

(1) The shipboard temperature environment is produced by three general factors: prevailing meteorological conditions, ship generated heat sources and the manner of heat absorption and distribution throughout the ship. The primary emphasis of the temperature investigation was to identify

[10] Shipboard Nuclear Weapons Security Program, Preliminary Survey of Environmental Data for, NSWC MP 79-131 of 4/15/79.

TABLE 2 GENERAL CHARACTERISTICS FOR SESF CRITICAL ENVIRONMENTS

ENVIRONMENT	NORMAL OPERATING LEVEL	WORST CASE LEVEL
1. ELECTROMAGNETIC RADIATION	30 dB DOWN FROM WORST CASE LEVELS SHIPBOARD MEASUREMENT PROGRAM COULD CHANGE THIS LEVEL	15 KHz TO 40 GHz MAXIMUM ENERGY LEVELS ARE SPECIFIED IN MIL–HDBK–235 (NAVY) FOR SHIPBOARD HANGER AND WEATHER DECK AREAS
2. VIBRATION	2–100 Hz WITH 2–20 Hz PREDOMINANT 0.3 G PEAK AMPLITUDE	2–100 Hz WITH 2–20 Hz PREDOMINANT
3. ACOUSTICS	22 Hz – 20 KHz 117 dB SHIPBOARD MEASUREMENTS PROGRAM COULD CHANGE THIS LEVEL AND FREQUENCY RANGE	165 dB 45 Hz – 10KHz NEAR AIRCRAFT AND ROCKET MOTORS
4. TEMPERATURE	30° TO +125°F	–40°F TO +160°F

TABLE 3 PRELIMINARY ENVIRONMENTAL CRITERIA FOR SHIPBOARD NUCLEAR WEAPON SECURITY SYSTEM.

Logistic Phase	Transportation - Handling (Packaged)				Storage - Handling (Packaged)		Ship Installation	
Environment	(a) Truck	(b) Rail	(c) Ship	(d) Air	(e) Land	(f) Sea	(g) External or Above Deck	(h) Internal or Below Deck
Vibration	Overall frequency range 3-150 Hz with predominant excitation in bands between 5-30 Hz and between 50-120 Hz. 90% of the acceleration peaks are below 2g and 99% are below 5g.	Overall frequency range 2.5-100 Hz with predominant excitation in bands between 2.5-7.5 Hz and between 50 and 70 Hz. In the low frequency band, 90% of the acceleration peaks are below 0.6g and 99% are below 1.2g; comparable figures for the high frequency band are 0.3g and 0.5g respectively.	Overall frequency range 2-100 Hz. The predominant range in the magazine areas is 2-20 Hz. 90% of the acceleration peaks are below 0.3g with 99% below 1g.	Overall frequency range 5-500 Hz. 90% of the acceleration peaks are below 4g or 0.03 in. p-p and 99% are below 10g or 0.1 in. p-p.	Vibrations more severe than those encountered during normal transportation may be experienced while moving material with hand trucks, forklifts, etc. The duration of such vibrations will be limited.	Overall frequency range 2-100 Hz. The predominant range in the magazine areas is 2-20 Hz. 90% of the acceleration peaks are below 0.3g with 99% below 1g.		
Shock	Road shocks of 10g peak and 20 ms duration may be encountered.	In normal travel, shocks are generally below 4g with 93% of the vertical shocks below 1g. - - - - - - - - - - During switching 95% of impacts occur at speeds below 12 mph and 99% at speeds less than 15 mph.	For sea states less than 2 the acceleration levels will not exceed those of Phase 1a. - - - - - - - - - - Shipboard shock for cargo ships: ΔV ~8 fps. Duration ~5 ms.	Takeoff and landing shocks are generally below 8g in any direction.	Significant during storage.	Peak step velocity change less than 5 fps - peak acceleration less than 40g as a result of normal on-loading and transfer. - - - - - - - - - - Shipboard shock velocity change: 10 fps Pk Acceleration: 120g	Shipboard shock velocity change: 28 fps Pk Acceleration: 400g	
Rough Handling	Free-fall drops may occur from various heights onto a variety of surfaces. Drop orientations are random. Typical, but not limiting, impact velocities are: 15 fps for items up to 20 lb, 14 fps for items between 20 and 50 lb, 12.5 fps for items between 50 and 200 lb, and 8 fps for items between 200 and 4000 lb.				Same as (a)-(d)	Same as (a)-(d)	N/A	N/A
Acoustic	N/A	N/A	N/A	N/A	N/A	N/A	Very near aircraft operation: 160 dB over frequency b.w. of 45 to 11,200 Hz. Very near rocket motor exhaust: 165 dB, 45 to 11,200 Hz. Other areas: 117 dB from 22 to 11,200 Hz reference level: 20 μPa	Any Area: 117 dB from 22 to 11,200 Hz.

TABLE 3 (CONTINUED)

<table>
<tr><th>Logistic Phase</th><th colspan="4">Transportation - Handling (Packaged)</th><th colspan="2">Storage - Handling (Packaged)</th><th colspan="2">Ship Installation</th></tr>
<tr><th>Environment</th><th>(a) Truck</th><th>(b) Rail</th><th>(c) Ship</th><th>(d) Air</th><th>(e) Land</th><th>(f) Sea</th><th>(g) External or Above Deck</th><th>(h) Internal or Below Deck</th></tr>
<tr><td>Air Temp. (High)</td><td>+133°F</td><td>+133°F</td><td>+125°F</td><td>+120°F</td><td>+125°F</td><td>+125°F</td><td>+125°F</td><td>+125°F</td></tr>
<tr><td>Temperature with Solar Radiation (High)</td><td colspan="7">High temperatures in conjunction with maximum intensity solar radiation of 355 BTU/ft^2/hr may cause container or compartment temperatures of 160°F and skin temperatures to exceed 160°F.</td><td></td></tr>
<tr><td>Air Temp. (Low)</td><td>-20°F</td><td>-20°F</td><td>-20°F</td><td>-30°F</td><td>-65°F</td><td>-20°F</td><td>-40°F</td><td>30°F</td></tr>
<tr><td>Pressure (High)</td><td>15.4</td><td>15.4</td><td>15.4</td><td>15.4</td><td>15.4</td><td>15.4</td><td>15.4</td><td>15.4</td></tr>
<tr><td>Pressure (Low)</td><td>10.1</td><td>10.1</td><td>12.8</td><td>1.7</td><td>10.1</td><td>12.8</td><td>12.8</td><td>12.8</td></tr>
<tr><td>Humidity (High)</td><td colspan="5">Saturation @ 95°F</td><td colspan="3">Saturation @ 95°F (43% @ 125°F)</td></tr>
<tr><td>Relative Humidity % (Low)</td><td><5</td><td><5</td><td>20</td><td><5</td><td><5</td><td>20</td><td>20</td><td>20</td></tr>
<tr><td>Corrosion</td><td>Moist Salt Atmosphere</td><td>Moist Salt Atmosphere</td><td>Moist Salt Atmosphere</td><td>Negligible</td><td>Negligible</td><td>Moist Salt Atmosphere</td><td>Moist Salt Atmosphere</td><td>Negligible</td></tr>
<tr><td>Icing</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Yes</td><td>No</td></tr>
<tr><td>Electromagnetic</td><td colspan="7">Maximum energy levels occurring in a frequency bandwidth of 15 kHz to 40 GHz are presented in MIL-HDBK-235(NAVY), parts 2 and 3, for shipboard hangar and weather deck areas. Levels in shipboard and shore station ordnance checkout areas are presented in Table III of part 2. No data are presented for factory to checkout areas.</td><td>Magazine areas are at least 30 dB lower than above-deck areas.</td></tr>
<tr><td>Atmospheric Pollutants</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Engine Industrial Exhausts</td><td>Negligible</td></tr>
<tr><td>Precipitation (Worldwide Extremes)</td><td colspan="2"><u>Snow</u>
1.2 to 1.5 inches per hour. Snow crystals 1 to 3 mm dia.; wind, 40 mph; temperature, 0°F</td><td colspan="3">Rainfall
<table><tr><th>Period (minutes)</th><th>Worldwide 5 year expectancy for a point (in./hr)</th><th>Worldwide all-time envelope for a point (in./hr)</th></tr><tr><td>1</td><td>19</td><td>112</td></tr><tr><td>5</td><td>9</td><td>48</td></tr><tr><td>10</td><td>7.5</td><td>36</td></tr><tr><td>30</td><td>5.6</td><td>22</td></tr><tr><td>60</td><td>3.8</td><td>15</td></tr></table></td><td colspan="2"><u>Hail</u>
Hail, accompanying well developed thunderstorms, may be encountered during the summer months in the mid-latitude areas of the world. hailstones range in size from <0.2 in. dia. to >4.0 in. dia. The largest hailstone on record had a dia. of 5.4 in. and weighed 1.5 pounds.</td><td>N/A</td></tr>
</table>

information sources which characterized the thermal radiation environment in ship compartments. However, because of the need to also determine temperature survivability requirements and in recognition of the relationship between thermal radiation and temperature, all available sources of shipboard temperature data were surveyed.

(2) The investigation revealed that sources of data pertaining to the temperature environment aboard naval ships can be classified in three general categories: temperature measurements made to support engineering design requirements for a particular piece or type of equipment, those made for safety purposes, and measurements and heat transfer studies made to support researchers in the development of infrared ship sensing devices. Although military specifications are available as guidelines, temperature design requirements for shipboard equipment are determined from the experience and expertise of design engineers, with inputs from specific project support testing. Only when the shipboard temperature environment has been considered a critical factor to a specific project, or when problems with existing equipment are under investigation, has the expense of a temperature measurement program been undertaken.

(3) Temperature data, which are almost exclusively applicable to the survivability environment, were found to be too limited to be a basis for a complete prediction of the shipboard temperature environment. All of the data were taken over too short a period of time, too limited a geographic area, or too limited a number of ships, to be applicable in establishing extremes of the temperature environment for all ship types of interest to the SNWS Program. The shipboard survivability temperature extremes, therefore, were derived from the climatic extremes over sea given in Reference 11, rather than the limited data taken from published reports.

(4) The operability infrared environment primarily depends on thermal radiation and convection effects, but the data from the survey are insufficient to characterize these shipboard infrared radiation sources. No measurements of infrared radiation in ship compartments were found and only one report contained any compartment surface temperature measurements. The report identified only limited locations of surface temperature measurements that were performed on a particular type of ordnance; these data would be of little use in characterizing the radiation levels from major background sources such as the bulkheads of the compartment. External surface temperature measurements taken on the deck, hull, and superstructure of the ships identified in the survey are concentrated on the hull and stacks of the ships and therefore would have little application to characterizing a background radiance in which to detect an intruder. No shipboard surface temperature measurements therefore were found to be applicable to SNWS operability requirements.

c. Shipboard Vibration Environment. A large amount of vibration data is available to suitably define the vibration survivability criteria. However, the information is insufficient to provide operability criteria. Details follow:

[11] Climatic Extremes for Military Equipment, MIL-STD-810B, 1973.

(1) The most significant shipboard vibration sources are the propulsion system and the effects of hydrodynamic forces acting on the hull. Vibration produced by the propulsion system is created by mass unbalances in the propellers, shafts, gearing, and reciprocating and auxiliary machinery. These sources produce harmonic excitations throughout the ship but tend to diminish at more remote locations. Deck and interior mounted machinery, such as turbines, generators, blowers, etc., contributes to the overall environment. However, the levels generated are generally more localized to the vicinity of the equipment. The hydrodynamic effects include wave interaction against the hull and slamming of the hull during rough sea conditions. Slamming results in transient vibration which tends to excite the hull at its normal torsional and bending modes. This response is sometimes called whipping. This type of response is independent of the ship's blade and shaft excitation frequencies. These modes generally occur below 5 Hz and are most pronounced at fundamental ship mode frequencies. Less pronounced hydrodynamic effects include Karman vortex shedding off of appendages such as stabilizers, rudders, and diving planes on submarines. Extreme maneuvers such as hard turns and reductions or increases in engine power are also significant contributing factors. The transient reponse environment produced by gun blast and rocket launch may be more appropriately called shock data.

(2) The ultra low frequency or seismic (rigid body) vibration environments characterized by the ship's roll, pitch, and heave motions are dictated primarily by ship size and the physical spacing and height of waves (sea state) interacting with the ship. Generally, classes of smaller ships exhibit the highest angular excursions and frequencies in the roll and pitch modes as compared to larger ships operating in the same sea conditions.

(3) Although the vibration data survey revealed wide variations in the measured levels for a particular ship class and operating condition, the values mostly pertained to equipment survivability criteria. Thus the documented range of vibration levels indicates that the overall survivability environment is adequately defined by Table 3. However, the existing data does not adequately define the operational environments; the characterization of the environments requires more detailed knowledge of the vibration time histories (amplitude, phase and frequency spectra).

d. Shipboard Acoustical Environment. Very little acoustic data are available. Measurements exist for determining habitability requirements that may partially satisfy survivability criteria, but no data are available for operability criteria. Details follow:

(1) Airborne noise aboard ship originates from essentially two types of sources: those associated with physical vibration of ship structures and equipment, and those associated with pressure disturbances caused by such things as gun fire and rocket launching. There are no methods for directly correlating mechanical vibration and airborne noise magnitudes and frequencies in a complex environment (such as a shipboard compartment) without extensive measurements. Long duration or ambient noise sources can be traced to equipment, and bulkhead and deck vibrations forced by: electrical and diesel motors; rotating equipment such as pumps, compressers, generators and turbines; flow induced vibration in valves, pipes, and air blowers; vibration of large transformers, and ventilation ducts and fans; sonar operation; and strong winds and high sea states. Sources of shorter duration but perhaps of greater intensity are gun blast, rocket motor

exhaust, and aircraft operation including launching, flyby, and landing. Personnel generated noise exists to some extent in control rooms, lounge and mess areas, galleys, and are caused by such things as intercom and loudspeaker systems. A complete description of the shipboard acoustical environment would include response to all of these variable inputs and describe the environment in a time history fashion as a function of ship speed/shaft rpm, ventilation fan speed, sea state, mission operational status, and the percentage of on-board equipment that is operational.

(2) The total frequency spectrum considered to be applicable to the SNWS program extends from 1 Hz to 50 KHz. Normally, this bandwidth is subdivided into categories of infrasonic frequencies (below 15 Hz), audio frequencies (15 Hz to 20 KHz), and ultrasonic frequencies (above 20 KHz). The total band was selected to cover areas that are normally considered both for survivability of equipment operation in high noise levels and for the operating range of typical alarm devices that use acoustic signals for intrusion detection. Alarm systems that use or monitor acoustic sources typically operate in the frequency range of 20 KHz to 50 KHz and may be active or passive devices. For operability considerations, accurate and extensive time history information will be necessary to select bandwidths suitable for shipboard use and define the environment sufficiently for development of a system that will operate satisfactorily without false alarms.

(3) The somewhat limited data available on airborne noise aboard ship was taken mainly to verify that habitability requirements had been met, thus the information obtained via these literature surveys can be classified as habitability data. The spectrum normally covered for this purpose extends from 5 Hz to 20 KHz. Various specifications dictate the maximum allowable sound pressure levels (SPL) as a function of frequency and compartment type. The purpose of the limits is to ensure: (1) comfort, (2) voice communication assurance, and (3) hearing loss avoidance. These data taken are usually average rms levels as a function of compartment type, position in compartment, ventilation fan speed, and ship speed or shaft rpm. Generally, one or more measurements are taken in common areas such as: (1) engine rooms (lower, middle, and upper levels), (2) control and navigation rooms, (3) radio and sonar control areas, and (4) officer and crew berthing and mess areas. These data are not primarily oriented toward establishing equipment design criteria. However, they may be useful to partially satisfy background environmental data requirements in terms of survivability of the intrusion detection system. The survivability considerations of such a system (i.e., to ensure long failure intervals and correct operation) will probably not be heavily affected by acoustic airborne noise. However, if it is determined that the levels typically found in habitability measurements are not high enough to cause damage or malfunction, the data could be used to exclude areas where survivability would be a problem. Levels that could cause survivability problems may be limited to very local areas below deck (i.e., very near loud sources such as exhausting air or steam valves) or to above deck areas near sources such as gun blasts and aircraft operation. The rather limited variety of information obtained and the method and range in which it was taken and reported indicate that it will have little value in helping to establish operating levels of an acoustic detection system for use aboard ship. The relatively low levels cited also indicate that these data will have little or no impact upon component design in terms of survivability. Subsequent paragraphs in this section summarize the reviewed data in relationship to the requirements for survivability and operability.

(4) The survivability effects of acoustical airborne noise on electromechanical devices may depend on both level and frequency content. Damage would most likely be caused by the lower frequencies (e.g., below 20 KHz). The ultrasonic region of frequencies would not likely contribute much to survivability criteria. Even at high sound pressure levels, high frequency air pressure variations would not produce large amplitude vibration in devices, a major concern when attempting to predict failure caused by vibrational effects. Also, high frequency sound in air is damped out in much shorter distances than the lower frequencies. Unless the device is immediately adjacent to high frequency sources, it is not likely to receive very high levels. Based on the review of available shipboard data, no steady state noise (other than that caused by aircraft operation) levels are likely to exceed 100 dB, but short term (transient) gun blast levels could reach 150 dB. Reference 3 specifies test levels of 160 to 165 dB for equipment immediately adjacent to (and attached to) operating aircraft and rockets. Since it is conceivable that the intrusion detection system components could be required to operate in the direct noise cone acoustical environment of aircraft and rockets, it was determined that the worst-case above-deck environmental criteria should encompass the Reference 3 levels. Since no other levels approached these, the frequency range for the environmental criteria (Table 3) is taken to be that of Reference 3. If the devices are not to be exposed to the noise cone of operating aircraft or gun blasts, the noise level used for survivability could be reduced to the lower value stated in the environmental criteria.

(5) In general, noise levels aboard ship (in the frequency range covered by the available data) are highly dependent upon the compartment in which they were measured. The noise in any one compartment is more a function of the equipment operating in that compartment than of some other factor affecting every compartment and area aboard ship (such as ship speed). The fact that the relatively low levels of machinery vibration and noise caused by fans and moving air (the several most important sources) are readily damped out by intervening decks and bulkheads results in the noise in one compartment being almost independent of the noise of adjacent compartments (unless the compartment in question has no significant noise source of its own). Indeed, even in the same compartment noise levels vary widely with the location at which the measurements are taken. This can be caused by various factors including dead spots, echoes, noise damping by air and structures, and the blocking of sound by intervening structures. All these make accurate prediction of noise levels difficult or impossible.

(6) The operation of intrusion detection systems using acoustic signals relies on accurate knowledge of the way in which the acoustical environment will change in time. The range of frequencies usually used for such devices is from 20 KHz to 50 KHz. Since no shipboard data in this frequency range are available, and, more importantly, no time history data in any frequency range were obtained, no conclusions or observations can be drawn concerning the operability of intrusion detection systems with respect to the acoustical environment.

e. Shipboard Electromagnetic (EM) Environment. All data on the EM environment have been previously summarized as peak levels in military specifications and handbooks that present survivability levels for shipboard equipment. No suitable data are available for specifying the operational EM environment. Details follow:

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[3] See reference 3 on page 9.

(1) The shipboard electromagnetic environment is defined as the composite of electromagnetic energy over the frequency range of 14 KHz to 100 GHz. The environment includes man-made and natural sources to which personnel and equipment on board Navy ships could be exposed. Man-made sources include outputs from high power communications transmitters, fire control radars, navigation devices and/or electronic countermeasure (ECM) and electronic counter countermeasure (ECCM) equipment originating either from the ship's own operations or close-by sources (friendly or hostile). Natural sources include lightning or static discharges.

(2) The general Navy interest in the shipboard EM environment is associated with personnel safety and effects on equipment. Electronic equipment is especially vulnerable to this environment. Electromagnetic energy causes undesirable performance responses in the intended operation of equipment or systems and electromagnetic compatibility (EMC), which is defined as the capability of equipment or systems to perform their designed functions in the total electromagnetic environment without causing or suffering unacceptable degradation due to the EMI to or from other equipments/systems in the same environment.

(3) The electromagnetic environment design levels for shipboard equipment are presented in References 12 and 13. Representative maximum field intensity and power density values (peak and average levels) for hangar and weather decks and main beam emitters for selected frequency bands between 25 KHz and 40 GHz are included in Reference 12 (tables of values are in the classified section of the handbook). A more general table of levels (unclassified) is included in Reference 13. The data for both documents are based on numerous shipboard measurements for the hangar and weather deck levels and on computations for the main beam levels. Measurements involved extensive surveys of Navy ships to experimentally determine and record maximum field intensity or power density levels under many ship operating conditions. Theoretical determination of these levels is not feasible due to perturbations induced by reflections and discontinuities and by interference from multiple transmitting systems. Computations of the main beam levels assumed worst-case conditions.

(4) The effects of the electromagnetic (EM) environment on the survivability and operability of an intrusion detector system above and below decks must be considered. The most likely modes of failure would include localized heating damage to electronic components for concentrations of microwave energy or breakdowns due to high-voltage transients, especially in semiconductors and capacitive components. All types of systems (IR, acoustic, microwave, etc.) could be adversely affected by interference from the EM environment, where spurious electrical signals might cause malfunctions. Systems using microwave generating devices would be especially susceptible to the EM background at frequency ranges close to operating frequency of the device.

(5) Although the levels presented in References 12 and 13 provide a good guide in defining the electromagnetic environment which equipment on board ship will be required to survive and operate, any specific operational or installation condition that might preclude exposure to these levels should be

[12] Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment, MIL-HDBK-235, Parts 1, 2 and 3.

[13] Preclusion of Ordnance Hazards in Electromagnetic Fields; General Requirements for, MIL-STD-1385 (Navy).

considered. Since only power density and field intensity values at weather or hangar decks are given, other electromagnetic parameters such as pulse width, pulse repetition frequency, pulse rise and decay time, location, etc., should be considered in defining the environment. No time-amplitude data that might be used to define the EM background environment aboard ship were found.

(6) One of the more important parameters to consider for the security system is the electromagnetic environment in magazine areas (below decks). It has be estimated that electromagnetic energy levels will be attenuated by at least 30 dB in all below-deck magazine areas due to shielding by the steel structure of the ship. Here again, this is a general number that could be influenced by radiation leakage through conduits, open hatches, or similar paths.

(7) Electronic equipment intended for use on Navy ships must be qualified by procedures set forth in Reference 7. These procedures include a test plan that details specific test procedures to determine EMI (emission and susceptibility) characteristics of the equipment normally at test levels from Reference 12. This is an important consideration in the design of an intrusion detection system.

3.1.2 Representative Ship Spaces, Equipment and Interfaces.

The configurational features that are to be incorporated into the SESF involve the simulation of shipboard spaces where some element of a nuclear weapons security system may be located. These features involve those ship spaces, and associated equipments and interface characteristics, whose geometry, arrangements and proximity may affect the performance or installation of security systems with respect to technical or human engineering aspects.

3.1.2.1 The functional elements of a security system are detection, classification, localization, communication, response, and assessment. Security system hardware associated with the functional elements will be installed at differing locations throughout various ship classes, depending on the nature of the assets being protected. The Requirements Analysis task area (Work Breakdown Structure No. 10000 in Figure 1) has identified the following generic shipboard areas as those which security system elements would like installed:

a. nuclear magazines and adjacent spaces

b. small arms lockers

c. buffer zones/security stations

d. access trunks to nuclear magazines

e. weapons assembly and handling areas

f. nuclear weapon control stations

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[7] See reference 7 on page 9.

[12] See reference 12 on page 18.

TABLE 4 SESF REPRESENTATIVE COMPARTMENT SIMULATIONS

SHIPBOARD SPACE*	SHIP CLASS AE 26	AS 36	CG 27	CGN 38	CV 63	DD 963	FF 1052	LPD 4	SSN 637
NUCLEAR WEAPONS MAGAZINES	1	1	1	2	2	1	1	1	1
SPACES ADJACENT TO NUCLEAR MAGAZINES	0	0	2	8	2	1	2	2	0
BUFFER ZONES/ SECURITY STATIONS	0	1	0	0	2	1	0	1	0
ACCESS TRUNKS TO NUCLEAR MAGAZINES	2	2	0	0	2	0	0	1	0
ASSEMBLY/CHECKOUT AREAS	0	1	1	0	0	0	0	0	0
NUCLEAR WEAPONS CONTROL STATIONS	0	0	1	0	0	1	0	0	0
SECURITY ALARM SWITCHBOARD LOCATIONS	1	0	0	0	1	1	0	0	0
SMALL ARMS LOCKERS	1	0	1	2	0	1	2	1	0

*NOTE: THE NUMBER IN EACH MATRIX ELEMENT REPRESENTS THE NUMBER OF SPECIFIC TYPES OF SHIPBOARD SPACES, FOR THE GIVEN SHIP CLASS, THAT ARE CANDIDATES FOR THE ENVIRONMENTAL SIMULATION FACILITY.

TABLE 5 SESF REPRESENTATIVE COMPARTMENTS

SHIP	COMPARTMENT TITLE	LOCATION	
A. CG 27	1. Missile Assembly Area (Mag. Access)		1–35–01–M
	2. Missile Weapon Control Room		2–61–2–C
	3. Missile Director Control Room		3–61–0–C
	4. CPO Mess Room and Lounge		1–62–2–L
	5. Small Arms Locker		1–133–2–A
	6. Nuclear Weapons Magazine		5–47–0–M
	7. Missile Assembly & Loading Area		1–47–01–M
	8. CIC		03–76–0–C
B. CGN 38	1. MK 26 Magazine	3–58–0–M	3–231–0–M
	2. Ordnance Shop & Armory		2–259–2–Q
	3. Crew Living Complex	3–58–2–L	3–226–4–L
	4. Fan Room & Msl. Service Area	4–58–0–Q	4–226–0–Q
	5. Generator Room	4–58–2–E	4–231–1–E
	6. Emergency Switchgear Room		3–241–0–E
	7. Barber Shop	3–74–0–Q	
	8. Small Arms Magazine	2–84–0–M	
C. DD 963	1. Magazine		2–1/2–104–O–M
	2. Passage (and Security Station)		1–94–01–L
	3. Bosum Storeroom		2–94–O–A
	4. Damage Control Central		2–272–O–C
	5. Armory		2–479–2–Q
	6. C.I.C.		02–139–O–C
D. FF 1052	1. Magazine (ASROC & HARPOON)		1–44–0–M
	2. Fan Room		1–54–1–Q
	3. Small Arms Locker		1–93–1–A
	and Passage		1–73–02–L
	4. Passage		1–50–1–L
	5. Small Arms Magazine		3–38–O–M
E. AE 26	1. Magazine		3–70–O–M
	2. Trunk (to magazine)		5–86–2–T
	3. Eng. Dept. Office and DCC		2–121–2–Q
	4. Ordnance Shop and Armory		3–160–2–M
	5. Weapon Elevator Trunk (Hold 3)		5–79–2–T and
			5–70–1–T
F. AS 36	1. G.M. MK 28 Warhead Magazine		6–71–2–M
	2. Trunk (to magazine)		7–73–2–T
	3. Weapon Elevator Trunk		7–71–1–T
	4. G.M. MK 28 Shop		3–62–O–Q
	5. Security Station		2–72–2–Q

TABLE 5 SESF REPRESENTATIVE COMPARTMENTS (Continued)

SHIP	COMPARTMENT TITLE	LOCATION	
G. CV 63	1. Special Weapons Magazine	5-87-O-M	4-167-O-M
	2. Guard Office	3-223-2-Q	
	3. Security Station	3-87-2-L	2-168-2-Q
	4. Uptake Space		4-154-O-Q
	5. Trunk	6-96-1-T	5-175-1-T and 5-167-2-T
	6. Switchboard Room	5-97-1-E	
H. LPD 4	1. Magazine (Spec. Weapons)		6-68-O-M
	2. Passage (with Security Station)		3-68-1-L
	3. Dry Provision Storeroom		6-52-O-A
	4. Cargo Elevator		7-68-2-Q
	5. Cargo and Ammo Stowage		6-84-O-Q
	6. Deck Dept. Office (Sm. Arms Lkr.)		1-56-O-Q
I. SSN 637	1. Torpedo Room	Forward	

g. security alarm switchboard locations

h. weather deck areas

3.1.2.2 In the course of defining the shipboard measurements program (paragraph 3.1.1.5), the SEC task area determined that conducting characterization tests on a single ship from each of the 55 nuclear weapons capable ship classes was impractically time-consuming and costly. Consequently, this complete set of classes was reviewed to determine if it could be reduced without significantly compromising the technical objectives of the measurements program. The review addressed such factors as: numbers of ships in class; weapons carried; propulsion system (steam, gas turbine, nuclear), and ships to be overhauled or stricken from service within the next five years. Subsequently, a final group of nine classes was selected; Table 4 is a matrix form presenting these classes versus the interior generic ship spaces of paragraph 3.1.2.1. The numbers in the matrix elements refer to the preliminary set of specific interior shipboard which the SEC task area has identified to be instrumented for the measurements program. These spaces are listed in Table 5. Some spaces in the matrix were deleted based on functional commonalities (leading to duplicative environmental measurements), and others do not exist on every ship class. Thus, Table 5 presents representative spaces; note that the final listing may be altered based on the results of shipboard visits by the SEC task area. Since weather deck areas not only provide initial off-board access routes to nuclear magazines, but also provide direct access to launchers and cannister-stored weapons (e.g. ASROC and TOMAHAWK), exterior ship spaces are also necessary for the simulation facility. Specific areas of interest include weapons launchers, ship sides, bows, and helicopter pads or decks. Security system performance in these areas is affected by weather conditions, deck arrangements and operation of on-board and off-board equipment. The SESF also requires that the simulated shipboard areas incorporate appropriate representative accesses (e.g. scuttles; hatches; doors; elevator panels). Further it is necessary that the various areas be equipped to simulate the following shipboard equipment interfaces which are likely to affect security system performance:

a. Air flows (convective currents, vibrations and noise emanating from air conditioning, heating and ventilation ducts and outlets).

b. Piping (steam or cooling water service through compartments which may cause a thermal effect on the security system).

c. Illumination (fluorescent and incandescent lighting; thermal, video and EMI effects).

d. Communication equipment (EMI, acoustic or static interference; also security systems may involve communications links between security stations).

e. Thermal background/emissivity (possible hotspots or coldspots which affect the security system).

f. Bulkheads (material composition affecting thermal characteristics and penetration resistance).

g. Ancillary equipment (cranes, forklifts, handling dollies, etc.; e.g., pneumatic equipment with associated acoustics).

h. Power, frequency and voltage (induced effects from steady state variations, transients, interruptions and power transfers).

i. Stray magnetic fields (induced effects by ship's power or electric motors at 60 Hz to 400 Hz).

j. Aircraft launch and retrieval (acoustics, shock and vibration effects)

k. Uptake spaces (thermal effects).

3.1.3 Capabilities for Simulated Operational Scenarios.

It is desirable that the integrated operation of the facility features described in paragraphs 3.1.1 and 3.1.2 (Environmental Conditions; Ship Spaces, Equipment and Interfaces) provide the capability for realistically simulating operational scenarios applicable to the installation, operation and verification of shipboard nuclear weapons security systems. Accordingly, the facility will support the following activities:

3.1.3.1 Investigation of Security System Performance. This includes aggressor/response force actions with realistic penetration trials. Since penetration attempts are not limited to designated entryways, replaceable panels/bulkheads are necessary for forced entry intrusion methods. Also a means to monitor, assess and referee the agressor/response force activities is necessary.

3.1.3.2 Investigation of Integration Requirements. The simulation facility will be used to determine the ability of shipboard security system to interface with security systems of other ships and of shore installations.

3.1.3.3 Investigation of Security Procedures. The development of security procedures requires knowledge of the functional relationships between security personnel and security equipment. The facility will be a test bed to obtain this knowledge.

3.1.3.4 Investigation of Personnel/Ship/Security System Interfaces. The operational effectiveness of security systems is strongly influenced by interactions with personnel and ship's equipment. To realistically investigate security system performance, these interfaces must be functionally interrelated similar to shipboard conditions.

3.2 FACILITIES SURVEY. A survey was conducted to determine if there were existing facilities capable of meeting the SESF technical requirements described in paragraph 3.1. The initial phase of the survey consisted of background research and

identification of References 14 through 18. Based on this source material, the capabilities of the facilities listed in Table 6 were examined with respect to SESF requirements. The survey also included a review of a Navy-sponsored study (Reference 19) which developed a general conceptual design for a combined environment test facility to be used for simulation testing of shipboard equipment. Facilities having the most promising capabilities or features applicable to the design of a new SESF were then visited to obtain detailed information which was unavailable in the reference documents.

3.2.1 Facility Survey Approach.

3.2.1.1 The format of the literature search involved assesing the capabilities of existing facilities with respect to the desired technical requirements of the SESF described in paragraph 3.1. Given the unique requirements associated with evaluating shipboard security systems, it was recognized that an existing test facility might not reasonably be expected to fulfill the desired testing capabilities of the SESF. Thus, although the primary goal was to identify an existing facility that would satisfy the SESF objectives, the literature search also recognized that the identification of existing test facilities which fulfilled some of the major testing requirements could still be of value. If the "ideal" facility did not exist, then the upgrading of an existing facility and/or the application of salient design features of unique test setups could save considerable time and money when compared to an alternative involving new facility construction.

3.2.1.2 In considering the SESF requirements, the literature search did not necessarily reject any facility on the basis that the testing capabilities did not exist in ship compartment configurations. Rather, it was postulated that if a facility possessed large scale testing capability for a given environment then such a facility was judged on its adaptability for accommodating mockups of ship compartments.

3.2.1.3 Given the relaxation of the compartment configurational constraint, the key features to be addressed in the literature survey were existence of large-scale testing capabilities for: (1) climatic effects, (2) vibration, (3) electromagnetic radiation, and (4) acoustics. If large-scale testing can be performed,

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[14] Navy Technical Facility Register, NAVMAT P-3999-1 (2 volumes) April 1973, Department of the Navy.

[15] DARCOM Test Facilities Register, DARCOM-P-70-1 (May 1976); US Army Material Development and Readiness Command.

[16] AF Technical Facility Capability Key, AFSCP 80-3 (1 September 1967)

[17] Technical Facilities Catalog (NASA) NHB 8800.5 (2 volumes)

[18] Index of Environmental Test Equipment in Government Establishments, Shock & Vibration Information Center, Naval Research Laboratory, Third Edition, November 1967.

[19] Final Report for Combined Environment Test Facility Study, Phase III, 4 June 1969, prepared by Huges Aircraft Co, Fullerton, CA for the Naval Electronics Laboratory Center under Contract N00123-69-C-0066

TABLE 6 FACILITY SURVEY SUMMARY

A. Navy Technical Facility Register, NAVMAT P–3999–1 (2 volumes) April 1973; Department of the Navy

	ACTIVITY	INFORMATION SURVEY	FACILITY VISIT
1.	Naval Aerospace Medical Research Laboratory	X	NO
2.	Naval Aerospace Recovery Facility	X	NO
3.	Naval Air Development Center	X	NO
4.	Naval Air Engineering Center	X	NO
5.	Naval Air Propulsion Test Center	X	NO
6.	Naval Air Test Center	X	NO
7.	Naval Air Test Facility	X	NO
8.	Naval Civil Engineering Laboratory	X	NO
9.	Naval Coastal Systems Laboratory (NCSC)	X	X
10.	Naval Electronics Laboratory Center (NOSC)	X	NO
11.	Naval Electronics Systems Test and Evaluation Facility	X	NO
12.	Naval Explosive Ordnance Disposal Facility	X	NO
13.	Naval Medical Field Research Laboratory	X	NO
14.	Naval Medical Research Institute	X	NO
15.	Naval Missile Center (PMTC)	X	X
16.	Naval Ordnance Laboratory (NSWC/White Oak)	X	X
17.	Naval Ordnance Missile Test Facility	X	NO
18.	Naval Research Laboratory	X	NO
19.	Naval Ship Research & Development Center	X	NO
20.	Naval Submarine Medical Research Laboratory	X	NO
21.	Naval Undersea Center (NOSC)	X	NO
22.	Naval Underwater Systems Center	X	NO
23.	Naval Weapons Center	X	NO
24.	Naval Weapons Evaluation Facility	X	NO
25.	Naval Weapons Laboratory (NSWC/Dahlgren)	X	NO
26.	Naval Weapons Handling Laboratory	X	NO
27.	Navy Clothing and Textile Research Unit	X	NC
28.	Navy Toxicology Unit	X	NO
29.	Pacific Missile Range (PMTC)	X	X

TABLE 6 FACILITY SURVEY SUMMARY (Continued)

B. DARCOM Test Facilities Register, DARCOM–P–70–1 (May 1976); U.S. Army Material Development and Readiness Command

	ACTIVITY	INFORMATION SURVEY	FACILITY VISIT
1.	Aberdeen Proving Ground/Material Test Directorate	X	X
2.	Aircraft Development Test Activity	X	NO
3.	Aviation Engineering Flight Activity	X	NO
4.	Air Mobility R&D Laboratory	X	NO
5.	Edgewood Arsenal	X	NO
6.	Frankford Arsenal	X	NO
7.	Picatinny Arsenal	X	X
8.	Rock Island Arsenal	X	NO
9.	Watervliet Arsenal	X	NO
10.	Electronics Command	X	NO
11.	Missile Command	X	X
12.	Tank–Automotive Command	X	NO
13.	Arctic Test Center	X	NO
14.	Dugway Proving Ground	X	NO
15.	Electronic Proving Ground	X	NO
16.	Jeffereson Proving Ground	X	NO
17.	Tropic Test Center	X	NO
18.	White Sands Missile Range	X	X
19.	Yuma Proving Ground	X	NO
20.	Ballistic Research Laboratories	X	NO
21.	Harry Diamond Laboratories	X	NO
22.	Human Engineering Laboratories	X	NO
23.	Mobility Equipment Research & Development Command	X	NO
24.	Natick Research & Development Command	X	NO

C. DARCOM Test Facilities Register (other Army facilities used by DARCOM and not previously listed)

	ACTIVITY	INFORMATION SURVEY	VISIT
1.	Air Defense Board	X	NO
2.	Airborne & Communications Electronics Board	X	NO
3.	Armor and Engineer Board	X	NO
4.	Artillery Board	X	NO
5.	Aviation Board	X	NO
6.	Combat Developments Experimentation Command	X	NO
7.	Engineer Waterways Experiment Station	X	NO
8.	Research Institute of Environmental Medicine	X	NO
9.	TRADOC Combined Arms Test Activity	X	NO

TABLE 6 FACILITY SURVEY SUMMARY (Continued)

D. DARCOM Test Facilities Register (other Navy/Marine Facilities not described in Navy Technical Facility Register)

ACTIVITY	INFORMATION SURVEY	FACILITY VISIT
1. National Parachute Range	X	NO
2. Naval Ammunition Depot (Hawthorne, NV)	X	NO
3. Naval Weapons Support Center	X	NO
4. Marine Corps Development & Education Command	X	NO
5. Marine Corps Tactical Systems Support Activity	X	NO

E. DARCOM Test Facilities Register (U.S. Government activities outside DOD)

ACTIVITY	INFORMATION SURVEY	FACILITY VISIT
1. Ames Research Center (Air Mobility R&D Laboratory) (NASA)	X	NO
2. AURORA Facility (owned by Defense Nuclear Agency – operated by Harry Diamond Laboratories)	X	NO
3. NASA Wallops Station	X	NO
4. National Bureau of Standards	X	NO

F. DARCOM Test Facilities Register (Air Force Facilities used by DARCOM)

ACTIVITY	INFORMATION SURVEY	FACILITY VISIT
1. Air Force Flight Test Center	X	NO
2. Arnold Engineering Dev Center	X	NO
3. Rome Air Development Center	X	NO
4. Space & Missile Test Center (Western Test Range)	X	NO
5. Space & Missile Test Center (Eastern Test Range)	X	NO
6. Tactical Fighter Weapons Center Range Group	X	NO
7. 3246th Test Wing (Eglin AFB)	X	X
8. 4950th Test Wing (Wright–Patterson AFB)	X	NO
9. 6585th Test Group (Holloman AFB)	X	NO

TABLE 6 FACILITY SURVEY SUMMARY (Continued)

G. DARCOM Test Facilities Register (contractor–owned test facilities used to provide testing services to DARCOM)

CONTRACTOR	INFORMATION SURVEY	VISIT
1. AAI Corporation	X	NO
2. Accuracy Systems, Inc.	X	NO
3. AEL (American Electronic Labs, Inc.)	X	NO
4. Aerojet Ord & Manufacturing Co.	X	NO
5. Amron Corporation	X	NO
6. ARES, Inc.	X	NO
7. ARTEC Corporation	X	NO
8. AVCO Lycoming Division	X	NO
9. Bellmore–Johnson Tool Co.	X	NO
10. Boeing Aerospace Co.	X	NO
11. Boeing Vertol Co. (Boeing Center)	X	NO
12. Dayton T. Brown, Inc.	X	NO
13. Budd Company Technical Center	X	NO
14. Calspan Corporation	X	NO
15. Canadian Forces Proof & Experimental Test Estab.	X	NO
16. Chamberlain Mfg. Corp.	X	NO
17. Colt Industries (Firearms Div.)	X	NO
18. Continental Testing Laboratory, Inc.	X	NO
19. Electrical Testing Laboratories, Inc.	X	NO
20. Elite Electronics	X	NO
21. Emerson Electric Company	X	NO
22. Firestone Defense Research & Products (Firestone Tire & Rubber Company)	X	NO
23. Ford Aerospace & Communications Corporation (Aeronutronic Division)	X	NO
24. GATX Corporation (GARD, Inc.)	X	NO
25. General Electric Company) (Aerospace Controls & Elect. Systems Department)	X	NO
26. General Electric Co. (Armament Systems Dept.)	X	NO
27. General Environments Corporation	X	NO
28. H. P. White Laboratory, Inc.	X	NO
29. Hercules, Inc. (Allegany Ballistics Lab.)	X	NO
30. Hercules, Inc. (Industrial Systems Div.)	X	NO
31. Honeywell, Inc. (Government & Aeronautical Products Div.)	X	NO
32. Honeywell, Inc. (Marine Systems Division — Annapolis Operation)	X	NO
33. Hughes Aircraft Company	X	NO
34. J. B. Engineering & Sales Co., Inc.	X	NO
35. Kaman Sciences Corporation	X	NO
36. Keweenaw Research Center	X	NO
37. Maremont Corporation (New England Division)	X	NO
38. Martin Marietta Corporation	X	NO
39. McDonnell Douglas Astronautics Company	X	NO
40. New Mexico State University (Physical Science Lab)	X	NO

TABLE 6 FACILITY SURVEY SUMMARY (Continued)

G. DARCOM Test Facilities Register (contractor–owned test facilities used to provide testing services to DARCOM) (Continued)

CONTRACTOR	INFORMATION SURVEY	VISIT
41. Noise Unlimited, Inc.	X	NO
42. Oklahoma State University	X	NO
43. Olin Corporation (Winchester Western Div.)	X	NO
44. Purdue University	X	NO
45. Sanders Associates, Inc.	X	NO
46. Sikorsky Aircraft	X	NO
47. Southwest Research Institute	X	NO
48. Stanley Aviation Corporation	X	NO
49. University of Maryland	X	NO
50. University of Wisconsin	X	NO
51. Wright–Malta Corporation	X	NO
52. Wyle Laboratories	X	X

H. Other Air Force Test Facilities

	INFORMATION SURVEY	VISIT
1. US Air Force School of Aerospace Medicine	X	NO
2. Wright–Patterson Air Force Base	X	NO
3. Air Force Special Weapons Center	X	NO
4. Air Force Cambridge Research Laboratories	X	NO

I. Other NASA Test Facilities

	INFORMATION SURVEY	VISIT
1. Marshall Space Flight Center	X	X
2. Flight Research Center	X	NO
3. Goddard Space Flight Center	X	NO
4. Jet Propulsion Laboratory	X	NO
5. Johnson Space Center	X	NO
6. Kennedy Space Center	X	NO
7. Langley Research Center	X	NO
8. Lewis Research Center	X	NO
9. National Space Technologies Laboratories	X	NO

J. Department of Energy Test Facilities

	INFORMATION SURVEY	VISIT
1. Argonne National Laboratory	X	NO
2. Los Alamos Scientific Laboratory	X	NO
3. Sandia Corporation – Livermore Laboratory	X	NO

then compartment mockups for systems testing could possibly be accommodated, as well as conventional component-type testing. Although the remaining environmental testing capabilities listed in Table A are nonetheless important, these four environmental effects were selected as key features because they represent the largest outlays of space, equipment and expenditures. Thus, facilities having these four testing capabilities were considered potential SESF candidates for upgrading, via facility expansion or modification, to provide the balance of survivability testing capabilities derived of the SESF. The survey assessed facility capabilities with respect to these four key parameters in accordance with the following guidelines:

a. climatic effects capability: large chamber capable of being divided into multiple room-sized ($\approx$1000 ft^3) subchambers, or several separate room-sized chambers; temperature control from -65°f to $+160^{\circ}$F; relative humidity to $\geq$ 95%; rainfall and ice formation tests desirable.

b. vibration capability: two or more large vibrators capable of exerting $\geq$ 20,000-lb force over the frequency range of 2 to 100 Hz (for handling compartment-sized test chambers); combined temperature testing (-65°F to $+160^{\circ}$F) desirable.

c. electromagnetic radiation capability: large chamber for performing the susceptability test (conducted and radiated) specified in References 7 and 8; frequency range down to 30 Hz is applicable.

d. acoustic capability: less heavily weighted factor since it appeared easier and less costly to add this capability than the other factors, especially if interior versus exterim conditions were of more importance; frequency range of 1 Hz to 50 KHz.

3.2.1.4 In addition to environmental testing capabilties, other factors considered in the literature search were: the capability of an existing facility to support the SNWS work with instrumentation and personnel; and, the anticipated availability of the facility to serve as the SESF.

3.2.2 Facility Survey Results.

3.2.2.1 Most existing test facilities were rated as inadequate to serve as the SESF based solely on the literature search. Such facilities were eliminated from consideration after comparison of their capabilities with the key parameter guidelines and other technical requirements. A few facilities initially were entered as potential candidates, but were subsequently eliminated when other facilities were identified with clearly superior capabilities with respect to SESF requirements. Table 6 presents a composite listing of all the facilities which were considered in the literature search. It includes those facilities rejected solely on the basis of the literature search, and those that were subsequently visited to obtain more detailed information pertaining to their environmental testing capabilties. This table is rather exhaustive in the area of government controlled facilities; but may be incomplete with respect to private industry facilities.

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[7] See reference 7 on page 9.

[8] See reference 8 on page 9.

Reference 20, pertaining to industrial testing capabilties, could not be reviewed since the document was not received prior to the end of this study phase. Although the survey revealed that none of the facilities met the SESF requirements, several of the facilities appeared to have sufficient capabilties such that they might either be altered to meet SESF requirements or had features which might be useful in the design of a new SESF. More current information on this subgroup of facilities was obtained via telephone. Subsequently, the following facilities were selected for investigative visits to obtain detailed information:

a. Climatic Hangar Environmental Facility, Eglin AFB, Florida

b. Naval Coastal Systems Center, Panama City, Florida

c. Naval Ship Research and Development Center, Bethesda, Maryland

d. U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland

e. U.S. Army Armament Research and Development Command, Picatinny Arsenal, Dover, New Jersey

f. Marshall Space Flight Center, Huntsville, Alabama

g. U.S. Army Missile Research and Development Laboratory, Redstone Arsenal, Alabama

h. Wyle Laboratories, Huntsville, Alabama

i. U.S. Army White Sands Missile Range, White Sands, New Mexico

j. Pacific Missile Test Center, Point Mugu, California

k. Naval Surface Weapons Center, Silver Spring, Maryland

3.2.2.2 SUMMARY OF VISIT TO EGLIN AFB.

a. Eglin AFB maintains a large Climatic Hangar Environmental Facility, but has no other test facilties of interest to the SNWS Program. The prime feature of the climatic laboratory is the main chamber, which is essentially an insulated aircraft hangar with dimensions of 252 feet wide by 201 feet long by 70 feet high in the center. Temperature within the chamber can be varied from $-65^{o}F$ to $165^{o}F$ and icing, rainfall and wind tests can also be performed. In addition to the main chamber, there are several smaller ones with comparable testing capabilities; there are also special chambers for salt spray, sun and wind tests. The main chamber was built in 1974 at a cost of approximately six million dollars. Operating costs are currently about $1,500 per day.

b. The capabilities of the Eglin facility for large-scale temperature, humidity, rain and wind testing are very impressive, but there is no attempt to simultaneously simulate other environments (such as vibration) within the various

[20] Facility Survey, Institute of Environmental Sciences, 1965 and 1966 Supplement.

test chambers. It is noteworthy that salt spray and dust environments have separate, dedicated chambers to limit effects on facility assets. Configurational requirements, if any, are provided by the user (e.g., the multiple component structures of a mobile Army field medical unit). It would be technically feasible to fabricate an inner structure within the main test chamber which would incorporate other environments and configurations of interest to SNWS Program, although to use the main chamber as such an enclosure would be somewhat of an overkill. Depending on SNWS requirements, it could also tie up a unique, operational asset which the Army and Air Force often utilize for equipment evaluation. It is highly unlikely that the Navy could obtain dedicated use of the facility for several consecutive years.

3.2.2.3 SUMMARY OF VISIT TO NCSC, PANAMA CITY, FL.

a. The primary purpose of the visit was to obtain information on the Waterborne Intrusion Detection Segment (WIDS) relevant to SNWS Program planning requirements. The literature search had previously revealed that the NCSC had no environmental testing capabilities of interest to the SNWS Program.

b. Although information is limited because WIDS equipment is still in a technology/development phase, it appears that complete environmental testing of the system within the scope of the SESF would be highly impractical, if not impossible. Environmental factors influencing WIDS performance will include water depth, surface conditions and subsurface temperature/salinity layering. As presently envisioned, the SESF will address systems installed aboard ship; thus, the applicability of the SESF to support WIDS testing would be limited to those components/subsystems which could be meaningfully evaluated without complete system deployment in a water intrusion detection environment.

3.2.2.4 SUMMARY OF VISIT TO NSRDC, BETHESDA, MD.

a. The primary feature at NSRDC of interest to the SESF is the Free-Form Test Facility which is used for dynamic testing (fatigue and load bearing) of large scale structural models of ship sections. Its operation and capabilties are described in Reference 21. The facility is essentially a huge programmable hydraulic vibration system with a capability for up to 60 hydraulic rams used as vibration inputs. It is of potential interest to the SESF if ship motion testing is required.

b. Advantages of this facility in support of the SESF include: (1) a large (70 ft W x 70 ft H x 200 ft L) existing building encloses the Free-Form Test Facility, and a part of it could probably be made available to the SNWS Program; (2) the building has 50-ton capacity overhead crane; (3) instrumentation and possibly computer modeling support are available; (4) gross ship motion could be simulated; and (5) the facility would be available in 1982-1983 and could possibly be dedicated to the SNWS Program.

c. Disadvantages include: (1) lack of a large climatic chamber; (2) lack of vibration equipment; although NSRDC has experience with large low

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[21] A Free-Form Test Facility for Large Scale Structural Models of Ship Sections or Components, NSRDC Report No. 2979, March 1971.

frequency mechanical vibrators which could be fastened to a compartment bulkhead to produce local vibration; (3) lack of acoustic testing capability; and (4) lack of electromagnetic radiation testing capability.

d. For those SESF Options for which gross ship motion simulation is unnecessary, then NSRDC can be eliminated for consideration as a potential SESF site.

3.2.2.5 SUMMARY OF VISIT TO ABERDEEN PROVING GROUND, MD.

a. APG has two test facilities of potential interest to the SESF: an EMI test enclosure and large climatic chambers.

b. The overall dimensions of the EMI enclosure are 94'L x 60'W x 28'H and the enclosure is equipped with a 16' x 16' access door. The facility is more than capable of performing all the EMI tests required by the tri-service military standards 461A and 462 (References 7 and 8). The EMI facility is also capable of microwave exposure testing up to a frequency of 18 GHz. The EMI facility was built inside a large building formerly used as an aircraft hangar at a cost of approximately $750,000 dollars. The facility would cost approximately 1.5 million dollars to duplicate today. A description of the facility and its capabilities is given in Reference 22. The schedule for facility usage was considered sufficiently uncommitted to accommodate the SNWS Program in the 1982-1983 time period. Aberdeen Proving Ground would not be adverse to constructing mock-ups of ship compartments inside the EMI enclosure as long as the mock-ups were constructed such that they could be easily dismantled.

c. APG has several older, large climatic chambers currently in operation which could meet the temperature extremes of the SNWS program. However, the climatic chamber of most interest to the program is the new climatic chamber currently under construction. The chamber is being built inside a former aircraft hangar at a cost of approximately 1.5 million dolars. The chamber is scheduled for completion by late 1980 and would be capable of providing all the temperature and humidity testing capabilties desired of the SESF. Possibly one-half of the chamber could be dedicated to the SESF. The Proving Ground personnel were not adverse to construction mock-ups of ship compartments inside the chamber as long as the mock-ups could be dismantled.

d. Advantages of APG in support of the SESF include: (1) An existing outstanding EMI test facility which offered the best capabilities encountered during the SESF survey of existing facilities; (2) a new climatic test facility under construction which could possibly be partially allocated to the SFSF; (3) existing large buildings (former aircraft hangars) which could possibly be made available to the SNWS program; and (4) instrumentation support is available.

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[7]See reference 7 on page 9.

[8]See reference 8 on page 9.

[22]Instrumentation Directorate Bulletin 74-1, Electromagnetic Interference Shielded Enclosure, Headquarters U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, October 1975.

e. Disadvantages include: (1) no ship compartment mock-ups exist; (2) vibration test equipment used by APG located at Edgewood Arsenal which is 18 miles from the Proving Ground environmental test area and (3) APG's acoustic test capability is directed toward outdoor field testing. An enclosed acoustic testing capability would have to be provided.

3.2.2.6 SUMMARY OF VISIT TO PICATINNY ARSENAL, NJ.

a. Discussions with personnel operating testing facilities at Picatinny Arsenal revealed that the equipment has deteriorated over the past several years. Large maintenance expenditures would likely be required to actually obtain the testing capability listed for Picatinny Arsenal in Reference 15.

b. The large vibration facility at Picatinny Arsenal may be of interest to SNWS Program. This facility uses hydraulic vibration heads and a pumping system to achieve low frequency, high displacement vibration of very large items. A hydraulic vibration system may be superior to an electrodynamic system for this type of vibration. The large vibration system at Picatinny Arsenal is not currently in operation. Approximatley $200,000 would be required to rehabilitate it.

c. Other test sites are clearly superior to Picatinny Arsenal as potential SESF sites, although it appears possible that a hydraulic vibration system may meet the vibration requirements of the SESF.

3.2.2.7 SUMMARY OF VISIT TO REDSTONE ARSENAL.

a. Redstone Arsenal maintains large scale environmental testing capabilities in three of the four environmental test areas which are of most interest to the SNWS program. These areas are climatic effects, vibration, and electromagnetic radiation. Redstone Arsenal does not maintain an acoustic testing facility. When Redstone Arsenal requires acoustic testing support, the work is contracted to Wyle Laboratories, which is also located in Huntsville, Alabama. A description of the testing capabilities of Redstone Arsenal is given in Reference 23.

b. Redstone Arsenal has several large climatic chambers; the largest is 56 ft long by 27 ft wide by 13 ft high. This chamber is well maintained and is capable of meeting the climatic testing requirements desired of the SESF. The chamber was built by Aerojet General Corporation at a cost of approximately 1.5 million dollars. The chamber is not often used and could be made available to the SNWS program.

c. The large scale vibration test facility at Redstone Arsenal is a hydraulic system capable of exerting up to 100,000 pound forces with displacements

[15] See reference 15 on page 25.

[23] AS-A013 355, Test and Evaluation Directorate Facilities and Capabilities, U.S. Army Missile Command, Redstone Aresenal, Alabama, March 1975.

of up to five inches. The floor and three of the walls of the vibration test cell are huge reaction masses with millions of pounds of concrete and steel reinforcing bar. This hydraulic vibration system would make a good SESF vibration facility. The vibration system was built for Redstone Arsenal by Wyle Laboratories.

d. The large scale electromagnetic radiation testing facility at Redstone Arsenal is an outdoor facility. An enclosure or test cell would have to be constructured before the facility could be used to test a mock-up ship compartment with security system installed. The Arsenal also maintains a smaller indoor test facility for measuring the response of electronic equipment to an electromagnetic radiation environment.

e. The major disadavantages of Redstone Arsenal as an SESF site are: (1) the desired testing facilities exist individually at separate locations, not together in a central location as is desired of an SESF; and (2) Redstone Arsenal does not have an existing large building which could be made available to the SNWS Programs for large-scale mock-up configurations.

f. The Redstone Arsenal does not have as great a potential to serve as the SESF as does NASA's Marshall Space Flight Center, which is a tenant activity at Redstone Arsenal. However, the combination of Redstone and Marshall at one geographic location, with Marshall serving as the primary SESF site and with Redstone available for spinoff testing, meets several of the SESF requirements.

g. If large scale vibration testing is required, a candidate model for the SESF vibration system is the large hydraulic vibration system at Redstone Arsenal. This vibration system is similar to the one at Picatinny Arsenal, except the Redstone system is well maintained and is operational.

3.2.2.8 SUMMARY OF VISIT TO WYLE LABORATORIES, HUNTSVILLE, AL.

a. The Wyle Laboratories Scientific Services and Systems Group performs consulting engineering in environmental testing and in the construction of environmental testing facilities. Wyle Laboratories also maintains an environmental test laboratory with some capabilities of possible interest to the SNWS Program.

b. Wyle has a large hydraulic vibration system capable of exerting several hundred thousand pounds force on test items. This facility is often used to do earthquake testing on large (up to 30 tons) components for nuclear power plants. This vibration facility would be capable of doing shipboard vibration tests of full scale mock-ups of ship compartments.

c. Wyle also maintains an acoustic test facility with a 100,000 ft^3 test volume. Using this chamber to stimulate a shipboard acoustic environment would probably be a case of overkill. The chamber is capable of testing up to a level of 160 dB and is capable of frequencies up to 15 KHz.

d. Wyle does not maintain a large fixed temperature testing chamber. Instead, they configure custom chambers from prefabricated insulating panels on an "as required" basis. The chamber then uses electric resistance heaters for heating and liquid CO_2 for cooling. CO_2 would probably not be satisfactory for use in an SESF temperature chamber because CO_2 precludes human activity

inside the chamber during cold testing. But the concept of a variable size temperature chamber used in conjunction with mechanical refrigeration could be useful to the SESF climatic conditioning requirements.

e. Wyle Laboratories does not maintain an electromagnetic radiation test facility, nor did they have any experience with electromagnetic testing.

3.2.2.9 SUMMARY OF VISIT TO MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, AL.

a. The visit revealed the possibility of NASA assistance to the SNWS Program in the SESF task area and also in the Shipboard Environmental Characterization (SEC) task area. With respect to the former, Marshall Space Flight Center (MSFC) has test facilities applicable to many of the SESF requirements; possibly these facilities could be made exclusively available to the SNWS Program. Apropos the SEC task area, MSFC has expertise and experience in making environmental measurements, in environmental mapping of an area, and in maintaining and updating an environmental data bank. This knowledge was gained from space program problems of him to collect data to establish an environmental data bank, and then to manipulate the data bank to support a simulation facility; the SEC/SESF task areas are addressing correlative problems. NASA has developed a procedure for addressing such problems which they feel can be applied to the SNWS program. This procedure would include such things as where and how to take measurements to obtain an environmental map of the area of interest and how to use this data to simulate the environment in the laboratory. NASA has offered to share this expertise with the SNWS Program.

b. MSFC has a test facility which currently serves as a structural test area for large rocket propellant tanks. The building has walls and a floor built to withstand loads of millions of pounds. These masses of concrete could easily serve as reaction masses for any vibration or motion simulating equipment required of the SESF. The concrete structure of the building was designed as a basin to trap any liquids in the event a rocket tank burst during test. Thus the test area of the building is capable of holding water. If the basin were to be filled with water, a hydraulic loading system currently in operation could be programmed to give a barge/test platform ship motion in pitch, roll and yaw. As an alternate to a barge in water, the test platform could be placed on airbags with approximately the same results. Once the overall test platform exists, then it would be necessary to equip it with other environmental testing capabilities.

Adjacent to the test area of the building are several floors of office space, conference rooms, equipment rooms, instrumentation spaces, hallways and elevators which could provide SESF support functions and might possibly be configured as ship compartment mock-ups.

c. According to present NASA planning, within the next year NASA has no further use for this building. Unless some other organization makes use of it, the facility may be declared surplus. Thus apparently the facility could be made completely at the disposal of the SNWS Program.

3.2.2.10 SUMMARY OF VISIT TO WHITE SANDS MISSILE RANGE, NM.

a. WSMR maintains both large fixed chambers and large movable chambers for temperature testing. The large fixed chambers at WSMR are not capable of cycling between hot and cold extreme temperatures. One large fized chamber is used for temperatures between ambient and +180°F and another large chamber is used for testing between -65°F and ambient. The movable chambers consist of a shroud (insulating box) and a mechanical field conditioning unit (heating and refrigeration equipment). The shroud is moved on one large flatbed truck while the mechanical field conditioning unit is moved on a second truck. Shrouds are available to enclose a volume of up to 60 ft by 16 ft by 16 ft. The mechanical field conditioning unit can cool or heat this volume to any temperature between -80°F and +180°F, but the relative humidity is uncontrolled. The shroud and field conditioning unit concept may be a way to provide the SESF with a climatic effects capability which is less expensive than building a large fixed temperature chamber. The movable chamber might also provide some flexibility which is not available with a large fixed chamber.

b. WSMR has a hydraulic vibration system which is capable of providing the vibration testing capability desired of the SESF. The system consists of four 40,000 pound force hydraulic rams capable of 4-inch double amplitude displacement. Although this vibration system is adequate to meet the needs of the SESF, vibration systems better suited to provide the capability desired of the SESF exist at some of the other test sites visited.

c. WSMR has an extensive electromagnetic radiation effects testing capability. The large scale electromagnetic radiation test facility is located outdoors. As is, this facility would be suitable only for testing above-deck exposed security systems. A ship space mock-up would have to be built in the electromagnetic radiation test area for the facility at WSMR to provide all the electromagnetic radiation testing capability desired of the SESF. WSMR also has small indoor shielded chambers for electromagnetic radiation susceptibility test of electronics on a component scale.

d. The test facilities at WSMR of interest to the SNWS program are not located in one central area as would be desired of an SESF. The facilities are widely scattered several miles apart. Also, no existing building was available at WSMR which could be modified into ship-like compartments to use for intruder versus sensor system testing. A complete description of the testing facilities available at WSMR is given in Reference 24.

e. Perhaps the information of most significance to the SNWS program to come from the visit to WSMR was the discussion of the effects of nuclear radiation on shipboard electronics. Discussions were held with Mr. Flores of WSMR and Mr. Robert Jackson of Sandia Corporation on the subject of susceptibility of electronic equipment to the background nuclear radiation levels in shipboard nuclear magazines. Based on their experience with production of nuclear weapons and with equipment susceptibility testing, both individuals expressed the opinion that if the ambient levels are not hazardous to humans, then the ambient levels

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[24] Army Materiel Test and Evaluation Directorate Facilities and Capabilities, U.S. Army White Sands Missile Range, New Mexico

should cause no problems with electronic equipment. In general, humans are several orders of magnitude more susceptible to radiation effects than is electronic equipment. If there are no detectable biological radiation effects in a magazine, then there should be no concern over equipment susceptibility to radiation.

f. Other test sites exist with as much, or greater, potential to serve as the SESF site than WSMR.

3.2.2.11 SUMMARY OF VISIT TO PACIFIC MISSILE TEST CENTER (PMTC), PT. MUGU, CA.

a. PMTC has a large climatic test chamber (60 ft long x 63 ft wide x 25 ft high). This chamber can be divided into general smaller chambers via sliding partition walls. The chamber can operate between the temperatures of +165°F and -65°F. Rain and snow can also be produced inside the chamber. The capabilities of the chamber are more fully described in Reference 25. Except for the large chamber at Eglin Air Force Base, this chamber had the best capability of any encountered during the facility visits.

b. The primary feature of the electromagnetic compatibility (EMC) testing facility at PMTC is a large anechoic chamber designed for EMC testing of complete missile systems. The complete EMC testing capabilities at PMTC are described in Reference 26. This large chamber is capable of testing in frequency ranges from 50 MHz and 19 GHz. This chamber would not meet the range EMC testing capabilities desired of an SESF which are 30 Hz to 100 GHz. Also, the quiet zone inside the chamber is designed for the long cylindrical shapes. However, a chamber of similar design but tailored to SESF requirements could be developed; PMTC personnel estimated that the cost of such a chamber would exceed one million dollars.

c. The vibration testing capability at PMTC consists entirely of electrodynamic vibrators, the largest of which is capable of a force output of 30,000 pounds. Vibration facilities much better suited to the capabilities desired of the SESF exist at other test sites. However, PMTC was one of the few test sites visited which made a practice of doing combined environmental testing. PMTC often tests missile systems for vibration in combination with temperature and altitude. The concept of the SESF calls for combined environmental testing, but in general the facility visits revealed very little combined environmental testing is being done.

d. The test facilities at PMTC are scattered, not centrally located as would be desired of the SESF. There was no building at PMTC which could be modified to form ship-like compartments for inturder versus sensor system test. Pending availability of the chamber for such long-term support; such compartments could perhaps be built inside the large climatic chamber.

e. Although PMTC has an excellent climatic chamber which could form the nucleus of an SESF, other test facilities exist which are better suited to meet the overall requirements of the SESF.

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[25] Environmental Facilities, Pacific Missile Test Center, Point Mugu, California.

[26] Electromagnetic Compatibility Testing, Pacific Missile Test Center, Point Mugu, California.

3.2.2.12 SUMMARY OF VISIT TO NAVAL SURFACE WEAPONS CENTER, WHITE OAK, SILVER SPRING, MD.

a. White Oak has a relatively large (8 1/2 ft W x 8 1/2 ft H x 30 ft L) walk-in temperature and humidity chamber. The chamber has a removable partition at mid length that creates two separate chambers which can be operated independently at different temperatures.

b. The table load capabilities of the vibration equipment would not be adequate for mock-ups the size of shipboard compartments. The equipment is suitable for testing elements of a security system, but could not support tests in operational scenarios involving ship compartment configurations.

c. There is a large volume in an existing building at White Oak that might serve as a structure to house the SESF. The space measures approximately 20 ft W x 20 ft H x 400 ft L in Building 405, and it is available to the SNWS Program.

3.2.3 Facilities Survey Summary. Existing facilities provide neither the basic technical capabilities nor operational testing capabilities desired for the SNWS Program facility. Specifically, the following summary comments apply:

3.2.3.1 Although existing facilities can support component testing, they have inadequate capabilities for systems testing of shipboard security equipment.

3.2.3.2 The simulated operational effects of shipboard interface equipment applicable to the SNWS Program is not attempted.

3.2.3.3 Instrumentation capabilities applicable to evaluating security systems are limited.

3.2.3.4 Existing combined environmental testing capabilities are generally limited, and do not provide the combinations of environments pertinent to the SNWS Program.

3.2.3.5 Existing environmental test facilities provide no mock-ups or simulations of shipboard spaces.

3.2.3.6 Existing facilities cannot support realistic installation of shipboard security systems.

3.2.3.7 Existing test facilities cannot appropriately support security systems vs. intruder penetration trials.

3.2.3.8 Given their lack of configurational features and interface characteristics, existing test facilities are of little value for the development of security systems tactics and procedures.

3.2.4 Combined Environmental Testing (CET) Facility Study Report.

3.2.4.1 In the course of researching reference material for the facility survey, a report was identified that described a CET Facility Study. This study,

Reference 19, was performed for the Naval Electronics Laboratory Center (now the Naval Ocean Systems Center) in 1969. The objective of the study was to evolve a conceptual design for a CET facility which would simulate to the greatest practicable extent the actual environment encountered by equipment aboard Navy ships. The report did not consider new construction requirements since the contract work statement directed that the design concept be compatible with an existing building (80 feet wide x 120 feet long x 40 feet high) at NELC: also, shipboard interface requirements were not included. The study addressed requirements and design goals, system performance analysis, facility conceptual design, and a cost analysis.

3.2.4.2 CET REQUIREMENTS AND DESIGN GOALS.

a. The primary environmental parameters addressed were temperature, humidity, shock vibration and ship motion (roll and pitch only); environments involving a lower priority were salt spray, stack gas, acoustic noise and electromagnetic interference. These lower priority factors could be sacrificed, as necessary, to satisfy meeting the primary requirements. The specific test performance parameters of the environments were determined from various MIL SPEC documents. Operational limits for the facility were largely driven by the testing requirements, but were modified by such agents as test system weight, test power requirements, shock intensity and inclination limits. The total test platform weight was established at 25,000 pounds, and was capable of accommodating a simulated shipboard compartment sized at 16 feet x 16 feet x 8 feet high. These characteristics were derived primarily by considering simulated shipboard compartment size and representative densities of electronic gear. Also, the weight limit was influenced by its effect on the design of the shock and vibration system. Note that developments in shock and vibration equipment since 1969 may change some of the design contraints if the study were to be performed in 1979.

3.2.4.3 FACILITY GENERAL DESCRIPTION.

a. The CET design layout was configured to fit within the existing building described in paragraph 3.2.3.1. The test chamber itself, with thermal and RF shielded wall, was located in one corner of the structure; it was sized at approximately 44 feet long x 40 feet wide x 40 feet high.

b. The test platform within the test chamber was dimensioned for mounting the simulated shipboard compartment, or compartly sized weather deck equipment. It would be driven by eight 30,000-lb electrodynamic vibration-shock exciters and gimibaled about two horizontal axes for roll and pitch simulation. This commonality of vibration-shock and ship motion excitations precludes the imposition of a requirement for high intensity shock loadings of the levels associated with underwater explosions.

c. The air conditioning and climatic control equipments could be located in a 38 feet x 30 feet area abutting the test chamber. The primary data acquisition and systems control equipments were located on two levels adjacent to the test chamber.

[19] See reference 19 on page 25.

3.2.4.4 COST ANALYSIS SUMMARY. Presented in 1969 dollars; 1979 dollars to be estimated at $\geq$ 100% higher.

a. Test equipments ($3.5M)

Data Acquisition	$1,028,630
Environmental Control	$ 270,840
Vibration	$ 997,040
EMI	$ 275,130
Acoustic (estimate)	$ 100,000
SHIPS Action	$ 90,000
Climatic Control (estimate)	$ 250,000
Electrical Power	$ 462,000

b. Facilities structural engineering estimate ($400K)

Excavation	$ 8,000
Backfill and Compaction	$ 450
Concrete Work	$24,000
Floors (concrete work)	$14,000
Walls	$80,000
Insulation	$21,000
Test Chamber Door and Operating Mechanism	$14,000
Roof	$36,000
Heating and Ventilation	$52,500
Toilet Facilities, Sewage	$ 9,000
750 KVA Substation	$22,500
Electrical Distribution	$15,000
Lighting	$15,000
Overhead Crane	$55,000
Contingencies	$36,645

3.2.4.5 STUDY CONCLUSIONS.

a. Simultaneous simulation of shipboard ranges of shock, vibration, pitch, roll, electromagnetic and climatic environments in a combined environment test facility is feasible. Such simultaneous environmental testing will decrease total test time, as compared to sequential testing, and in addition will provide disclosure of synergistic modes of failure.

b. The procurement costs for a CET facility are strongly influenced by the mass of the test system.

c. Careful analysis and design effort will be required in order to finalize the characteristics of a test platform which does not have resonant frequencies within the nominal vibrational operating range.

d. The majority of CET facility cost items are the equipments; therefore, there would appear to be a rather weak relationship of test requirements and design conceptual characteristics; rather, it would appear that the stipulation of test requirements constitutes the singularly dominant cost factor.

3.2.4.6 STUDY RECOMMENDATIONS. A detailed design study should be performed prior to initiating a procurement program. This study should embrace, as a minimum, an examination of the following problem areas:

a. The design and analysis of the test platform support frame vibratory response characteristics (i.e. determine natural frequency, structural stiffness, transmissibility);

b. The design of EMI and thermal insulation systems;

c. Model testing for critical performance areas (e.g., ganged shaker excitation, EMI shielding, pitch and roll simulation in combination with vibration and shock).

3.2.4.7 STATUS OF STUDY. No action was taken on the recommendations of the report. Development of the facility was judged prohibitively expensive, and there was no further effort on the concept.

3.3 MILCON ANALYSIS.

3.3.1 Background.

3.3.1.1 The Facility Survey disclosed no existing facilities that presently provide the environmental, configurational and interface capabilities which are desired for the SESF. Some facilities were identified that could partially fulfill the requirements, but modifications would be necessary at the most promising locations, independent of the availability factor for the SNWS Program. Thus, an analysis of military construction programming was necessary in order to assess the impact of construction requirements on the overall SNWS Program schedule.

3.3.1.2 At present, there is uncertainty about the nature of the building or structure needed to house the SESF since no firm conceptual layout designs have been developed. Further, the present planning status is not sufficiently advanced to allow meaningful cost analyses which would support implementation decisions regarding whether to construct a new building or enlarge an existing building, or modify an existing building without structural changes, and where to locate the facility. Given this milieu, the MILCON analysis was directed towards researching the spectrum of military facility construction planning for requirements, procedures and scheduling information which might have applicability to the SESF. Note that in general, the construction programming regulations do not apply to the technical equipment not affixed as an integral part of the facility; thus, the procurement and installation of specialized environmental simulation test and mock-up equipment would be exempt from MILCON requirements. Documentary material used for the MILCON analysis included the Navy Facilities Project Manual (OPNAV Instruction 11010.2C, May 1974) and advance information to be included in a forthcoming revision.

3.3.2 MILCON Programming Options. The MILCON programming options available in FY79 can be grouped into two major categories, with corresponding subcategories as per the following outline:

3.3.2.1 REGULAR MILCON.

3.3.2.2 EMERGENCY CONSTRUCTION PROGRAM.

a. Minor Construction

(1) Specified Locations Minor MILCON (SLMM)
(2) Exigent Minor MILCON (EMM)
(3) Claimant Funded (Special Projects)

b. Major Emergency Construction

c. Major Restoration or Replacement of Damaged Facilities

3.3.3 MILCON Program Descriptions. The outline presented in paragraph 3.3.2 is expanded in the following sections to provide brief highlights of the various programming options:

3.3.3.1 REGULAR MILCON.

a. In general, projects costing over $500K are to be included in the annual military Construction Authorization and Appropriation Acts which provide authorization and funds for construction projects that have been developed to meet mission requirements. Specific regulations and procedures are included in OPNAV INST 11010.2C, and the forthcoming revision "D" to this instruction.

b. Project sponsors can substitute project funds (RDT&E) instead of competing for limited MILCON appropriations with high priority programs; funds so injected into the MILCON appropriations budget are "fenced" and cannot be absorbed by other projects.

3.3.3.2 EMERGENCY CONSTRUCTION PROGRAMS.

a. Minor Construction

(1) SLMM (Specified Locations Minor MILCON)

(a) Cost range: $100,001 to $500,000
(b) This is actually a subset of regular MILCON. SLMM identification, documentation, processing and programming are exactly the same as regular MILCON; such projects compete with larger projects for status and funding; no specific amount is set aside for SLMM submissions are reviewed on a project-by-project basis through OSD/OMB budget mark-up.

(c) As in regular MILCON, project funds can be injected into the appropriations budget for specified uses.

(2) EMM (Exigent Minor MILCON)

(a) Cost range: $100,001 to $500,000

(b) Approval authorities: CNO ($300K); ASN/M,RA&L ($400K); SECDEF ($500K); plus all projects over $300K require clearance from all four Congressional MILCON subcommittees.

(c) Congressional authorization and appropriation are on a lump-sum basis ($20M in FY79); all qualifying projects vie for these funds.

(d) Project sponsors cannot inject project funds since there is a Congressionally appropriated limit.

(e) All of the following four qualifying criteria must be met: (1) identified too late for last SLMM, (2) usable completion date required substantially sooner than next SLMM Program could provide, (3) no alternative to construction available (e.g., lease, etc.), and (4) one or more of the following nine eligibility conditions must be met:

(i) a new primary mission assignment cannot be implemented without the requested construction

(ii) unexpected growth in existing primary missions cannot be accommodated without the requested construction

(iii) unexpectedly rapid progress in a high priority R&D effort cannot be exploited without the requested construction

(iv) a hazard to life and property equating to occupational health and safety act, Category I, cannot be corrected without the requested construction.

(v) the requested construction is necessary to conform to regulatory or statutory requirements which must be complied with to continue performing primary missions.

(vi) unexpected, new items of major equipment, which are necessary to the performance of primary missions, cannot be put into operation without the requested construction.

(vii) the security of nuclear or other classified special weapons would be compromised without the requested construction.

(viii) the requested construction consists of essential alterations incident to repairs (funded from other than MILCON) which are immediately necessary to continue performing current primary missions.

(ix) unexpected loss or severe reduction in supporting utility sources or systems will jeopardize the ability to continue to perform primary missions without the requested construction.

(3) Claimant Funded Minor Construction

(a) Cost range: 0 to $100K (new construction); 0 to $75K (alterations)

(b) Approval authorities to $15K (new construction) or $25K (alterations), Commanding Officer; to $100K (new construction), or $75K (alterations) Major Claimant (CNM for the Naval Surface Weapons Center)

(c) Funding sources: RDT&E, NIF

b. Major Emergency Construction

(1) Cost range: \$500K to 20M

(2) Approval authorities: SECDEF must determine that project deferral to next MILCON is inconsistent with national defense efforts; armed services committees of Congress must be notified. Applicable for projects made necessary by changes in Navy missions occasioned by:

(a) unforseen security conditions
(b) new weapon developments
(c) new and unforseen R&D requirements
(d) improved production schedules
(e) revisions in tasks or functions assigned to a military installation; or for environmental considerations.

(3) Funding sources: No funds are appropriated, but each annual MILCON Authorization Act sets criteria and authorizes a specific total (\$20M for FY79). Approved projects must be funded via reprogramming from existing MILCON funds, or via sponsor injected project funds.

c. Major Restoration or Replacement of Damaged Facilities

(1) Cost range: as required

(2) Approval authorities: Congressional notification (ASC's) required, with following eligibility criteria:

(a) caused by "Act of God" - not normal deterioration

(b) cost to restore exceeds 50% of replacement cost. If less than 50%, classify as repair and fund with NIF.

(c) delay for funding in next regular MILCON would adversely impact on primary missions or be hazardous.

(3) Funding sources (no specific funds provided)

(a) 0 to \$100K use NIF

(b) \$100K to \$500K use EMM (with attendant reprogramming)

(c) \$500K requires reprogramming from regular MILCON annual Authorization Act.

3.3.4 Structural Options. The structural options available for housing the SESF include (1) new construction, (2) a combination of construction and alterations to an existing building which involves expansion of building floor space, and (3) alterations to an existing building without increasing usable area.

3.3.5 Analysis of Programming Options.

3.3.5.1 Table 7 compiles the information of paragraphs 3.3.3 and 3.3.4 into a matrix from which presents the available spectrum of military construction programming. This matrix reveals that, for projects costing greater than \$100K,

TABLE 7 MILITARY CONSTRUCTION PROGRAMMING

			MILITARY CONSTRUCTION CATEGORIES(1)					
				EMERGENCY CONSTRUCTION PROGRAMS				
				Minor Construction				
STRUCTURAL OPTIONS	Cost Limits	Funding Source(2)	Reg. MILCON	SLMM(3)	EMM(4)	Claimant Funded	Major Emerg.(5)	Major Restoration or Replacement(6)
New Construction	>$500K	MA	Yes	NA	NA	NA	Yes	Yes
	>$100K ≤$500K	"	NA	Yes	Yes	NA	No	No
	>$500K	Project	Yes	NA	NA	NA	Yes	No
	>$100K ≤$500K	Project	NA	Yes	No	NA	No	No
	≤$100K	Project	NA	NA	No	Yes	NA	NA
	≤$100K	6.5	NA	NA	No	Yes	NA	NA
Alterations (expansion)	>$500K	MA	Yes	NA	NA	NA	Yes	Yes
	>$100K ≤$500K	MA	NA	Yes	Yes	NA	No	No
	>$500K	Project	Yes	NA	NA	NA	Yes	No
	>$100K ≤$500K	Project	NA	Yes	No	NA	No	No
	≤$100K	Project	NA	NA	No	Yes	NA	No
	≤$100K	NIF & 6.5	NA	NA	No	Yes	NA	No
Alterations (No area changes)	>$500K	MA	Yes	NA	NA	NA	Yes	Yes
	>$ 75K ≤$500K	MA	NA	Yes	Yes	NA	No	No
	>$500K	Project	Yes	NA	NA	NA	Yes	No
	>$100K ≤$500K	Project	NA	Yes	No	NA	No	No
	≤$100K	Project	NA	NA	No	Yes	NA	No
	≤$ 75K	NIF	NA	NA	No	Yes	NA	No

(1) MA = MILCON Appropriations; Project = sponsor designated transfer of project (RDT&E) funds into MILCON appropriations.

(2) Each matrix element specifies the applicability of each construction category as a function of funding source and limit constraints.

(3) Specified locations Minor MILCON. A subset of regular MILCON.

(4) Exigent Minor MILCON (formerly Urgent Minor MILCON). In FY79, $20M lump sum authorized and appropriated for all EMM programs.

(5) Major Emergency. In FY79, $20M authorized, but nothing appropriated. Projects approved under this category must be funded via reprogramming of regular MILCON budget, unless project funds are substituted.

(6) Major Restoration or Replacement of Damaged Facilities. NIF funds if ≤ $100K; use EMM category if cost is > $100K, ≤ $500K. If > $500K, reprogram regular MILCON budget. Does not apply to the SESF.

only seven programming options are available for the SESF project, and these are the same for each of the three structural options. The seven programming options are:

a. Regular MILCON (> $500K), MILCON appropriations
b. Regular MILCON (> $500K), project funds
c. SLMM ($100K - $500K), MILCON appropriations
d. SLMM ($100K- $500K), project funds
e. EMM ($100K - $500K), MILCON appropriations
f. Major Emergency (> $500K), MILCON appropriations
g. Major Emergency (> $500K), project funds

(NOTE: For "alterations" work under NIF funding involving no area changes, NSWC is limited to $75K; thus, for such cases, the funding limit in item c above extends down to 75K, and becomes $75K-$500K).

3.3.5.2 For programs costing less than $100K, there are a total of four distinct programming options, each of which has a two-tiered approval level, as listed below:

a. Claimant Funded (project funds, applies to all three structural options: sponsor and Commanding Officer approval necessary up to $15K; sponsor and CNM approval required from $15K to $100K.

b. Claimant Funded (6.5 funds, applies to new construction option): Commanding Officer approval necessary up to $15K; CNM approval required from $15K ot $100K.

c. Claimant Funded (NIF/6.5 funds, applies to alterations/expansion): Commanding Officer approval necessary up to $15K/$25K; CNM approval required up to $100K.

d. Claimant Funded (NIF funds, applies to alterations): Commanding Officer approval necessary up to $25K; CNM approval required from $25 to $75K.

3.3.5.3 SUMMARY. Since the procedures and requirements for implementing the various construction programming options costing greater than $100K are independent of funding source, the effective number of options can be reduced from seven to five. Further, the relative simplicity of implementing programs costing less than $100K, regardless of funding source, facilitates combining all such projects into a single programming option. Thus, the matrix information presented in Table 7 and pargraphs 3.3.5.1 and 3.3.5.2 can be reduced to a construction programming chart consisting of only five options. This chart is presented in Table 8 although for clarity the five programming options are replicated for each of the three facility structual options. Further, as noted in paragraph 3.3.3.2 "SLMM" is actually a subset of "regular MILCON". Thus, the number of separate, distinct MILCON programming options available to the SESF Task Area is reduced to the following four options:

a. Regular MILCON and SLMM: >$100K, funded via MILCON appropriations or project funds.

TABLE 8 SESF CONSTRUCTION PROGRAMMING OPTIONS

FACILITY OPTIONS	COST BOUNDS	FUNDING SOURCES	CONSTRUCTION PROGRAMMING: REGULAR MILCON	SLMM	EMM	CLAIMANT FUNDED	MAJOR EMERGENCY
NEW CONSTRUCTION	> $500K	MA / PROJ.					
	≤ $500K > $100K	MA / PROJ.					
	≤ $500K > $100K	MA					
	0 – $100K	PROJ. / 6.5					
CONSTRUCTION ALTERATIONS (EXPANSION)	> $500K	MA / PROJ.					
	≤ $500K > $100K	MA / PROJ.					
	≤ $500K > $100K	MA					
	0 - $100K	PROJ. / NIF/6.5					
ALTERATIONS	> $500K	MA / PROJ.					
	≤ $500K > $75K	MA / PROJ.					
	≤ $500K > $75K	MA					
	$75K–$100K	PROJECT					
	0 – $75K	PROJ. / NIF					

LEGEND:
MA = MILCON APPROPRIATION
SLMM = SPECIFIED LOCATION MINOR MILCON
EMM = EXIGENT MINOR MILCON

b. Major Emergency Construction: >$500K, funded via MILCON appropriations or project funds.

c. Exigent Minor MILCON: >$100K, funded via project, 6.5 sources (>$75K if NIF funds).

d. Claimant Funded: 0 to $75K for project and NIF funding; 0 to $100K for project, NIF and 6.5 funding.

3.3.6 Construction Scheduling Discussion.

3.3.6.1 REGULAR MILCON AND SLMM. Figure 2 presents the schedule for the program/budget cycle if the SESF were to be constructed under either the regular MILCON for SLMM programs. It shows construction starting in FY83, approximately 18 months after the CNO project approval and NAVCOMPT submission cycle in June 1981. All MILCON documentation must be submitted prior to August 15, 1980 for the schedule shown in Figure 2 to be met. Based on previous experience, the NSWC Public Works Department has determined that about 21 months is a realistic time period for preparing a complete construction package for submission to the CNO/NAVCOMPT approval checkpoint. Consequently, the entire process from detailed project definition to construction startup requires approximately 39 months. Further, the CNO/NAVCOMPT approval checkpoint only occurs in June/July of a given fiscal year; thus, the scheduling cycle presented in Figure 2 can only be advanced or deferred in one-year increments. For example, this means a construction start in FY82 would not be possible since this would have necessitated initiation of detailed planning in October 1978.

3.3.6.2 MAJOR EMERGENCY CONSTRUCTION. Figure 3 presents the program/budget cycle for Major Emergency construction. Approval for this program (requirements listed in paragraph 3.3.3.2b) enables approximately four months to be trimmed from the nominal regular MILCON 21-month preparation/approval cycle which preceeds the CNO/NAVCOMPT approval checkpoint. Otherwise, the scheduling is the same as the regular MILCON/SLMM cycle. Thus, Figure 3 shows that a construction start in FY82 would require a "go-ahead" decision on detailed facility planning in approximately February 1979.

3.3.6.3 EXIGENT MINOR MILCON. The Exigent Minor MILCON construction program requires only about a 24-month period (although there have been extraordinary instances of as short as 12 months) from commencement of detailed design/initial submittals to start of construction. Figure 4 illustrates that project construction could commence in early FY82 even with detailed project definition and initial submissions starting as late as January 1980. However, the cost ceiling of EMM Projects is limited to $500K and such projects must qualify under the stringent approval criteria listed in paragraph 3.3.3.2a(2). Further, there is an appropriated ceiling on funding for such projects ($20M in FY79), and candidate projects must compete for these funds with all such projects within DOD.

3.3.6.4 CLAIMANT FUNDED CONSTRUCTION: Of all the construction programming options, the Claimant Funded approach offers by far the easiest and quickest method of project implementation. Figure 5 shows that only approximately 16 months are required from detailed project definition to start of construction. However, the critical factor of this program is the $100K cost ceiling.

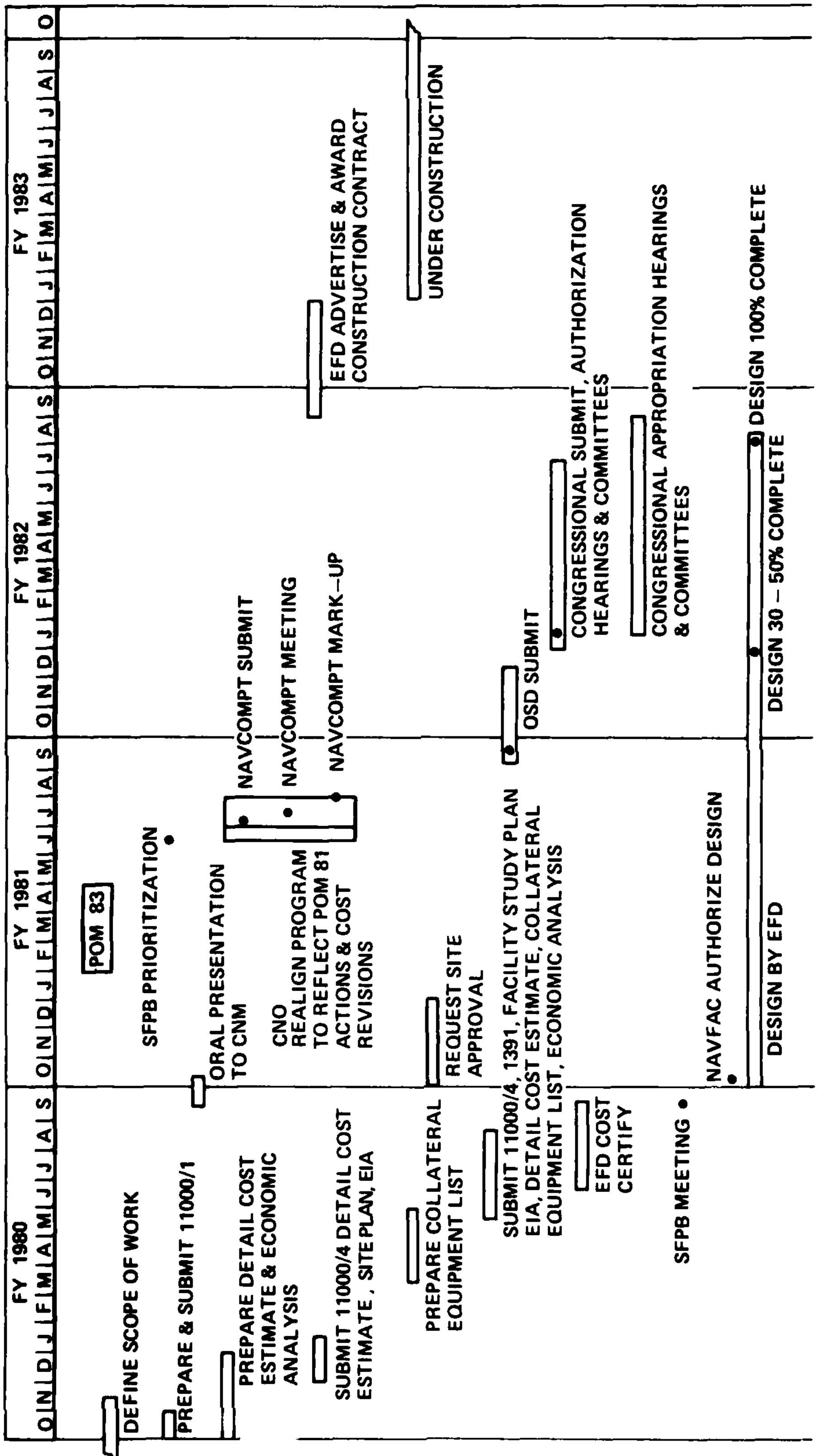

FIGURE 2 PROGRAM/BUDGET CYCLE: FY 83 REGULAR MILCON & SLMM PROGRAMS

Remarks:

a. OPNAV 11000/1 Form — "Basic Facilities Requirements List" which identifies the essential facilities required for the activity to perform its mission, (a detailed justification of space requirements).

b. OPNAV 11000/4 Form — "Correction of Facilities Deficiencies" is used when the activity has quantified and identified the means for satisfying project deficiencies requiring MILCON funding. Submission of a project on an 11000/4 permits entry of the project into the Military Construction Requirements List. This procedure allows all projects to be reviewed by command echelons. During the review, priorities for accomplishment are assigned and the project is placed in the MILCON program.

c. EIA — Environmental Impact Assessment

d. DD Form 1391 — is a Project Data Sheet which depicts clearly the basis of the military requirement and states strongly and unmistakenly the facts from which only one conclusion can be drawn, that the proposed project is the only reasonable means of satisfying the requirement. The form is also a vehicle for recording a detailed estimated cost and scope required to satisfy the stated requirement.

e. Facility Study — provides expanded and complete back up information and data in support of the project and contains all pertinent data required in the preparation of the DD Form 1391.

f. SFPB Meeting — Shore Facilities Planning Board Meeting at CNO level. All MILCON forms must be submitted and endorsed by CHESDIV/NAVFAC and NAVMAT by 15 August 1980 for consideration at the September SFPB meeting during which the FY83 MILCON approved projects list is complied.

g. EFD — Engineering Field Division. For NAVSWC it is the Chesapeake Division, Naval Facilities Engineering Command at the Washington Navy Yard.

h. NAVFAC — Naval Facilities Engineering Command in Alexandria, VA. NAVFAC is directly under CNO.

i. POM — Program Objectives Memorandum from Department of the Navy to Department of Defense. (Listing of MILCON projects submitted for funding)

j. NAVCOMPT — Navy Comptroller

k. OSD — Office of Secretary of Defense

FIGURE 2 PROGRAM/BUDGET CYCLE: FY83 REGULAR MILCON & SLMM PROGRAMS (CONTINUED)

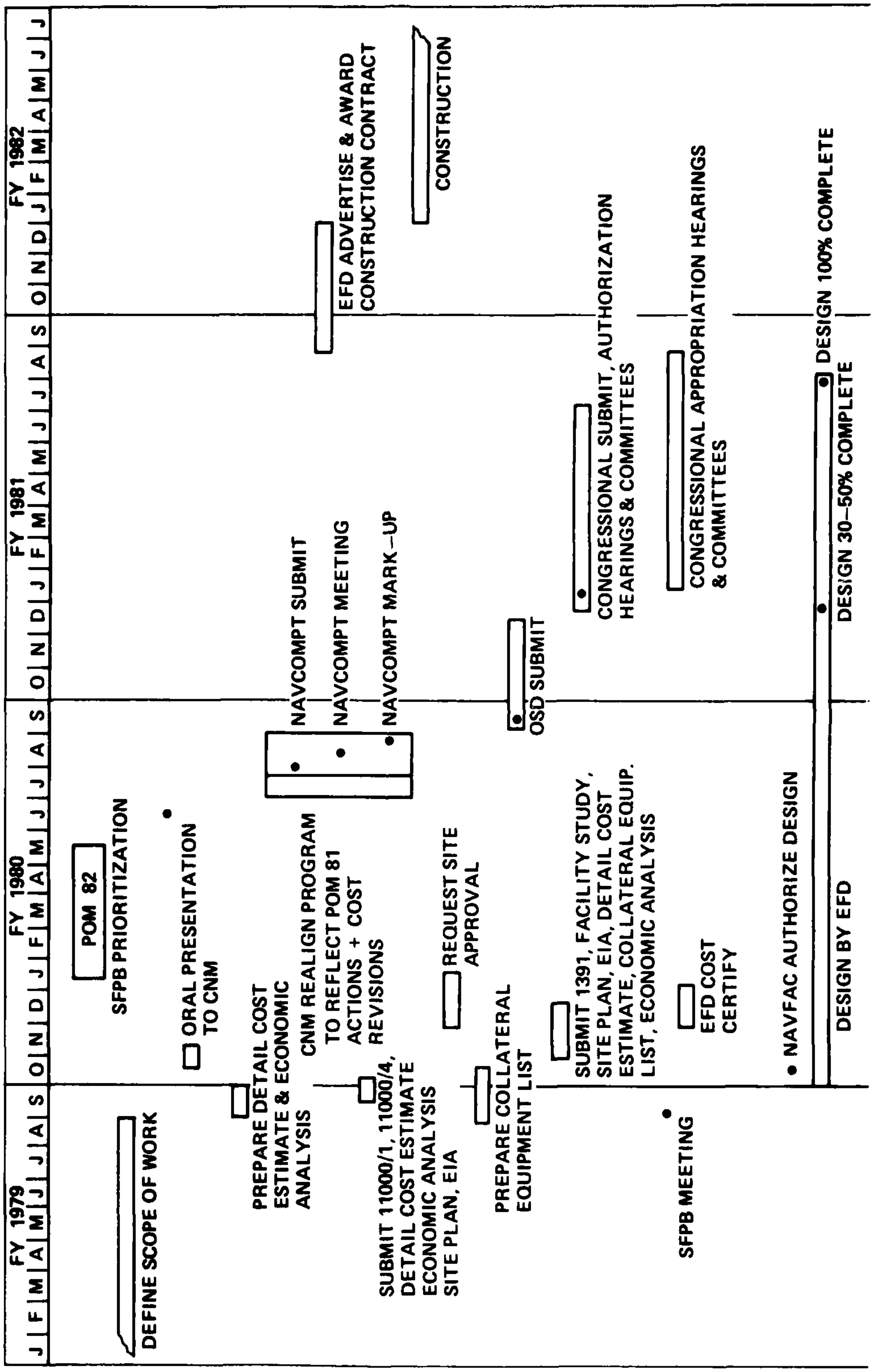

FIGURE 3 PROGRAM/BUDGET CYCLE: FY 82 MAJOR EMERGENCY CONSTRUCTION PROGRAM

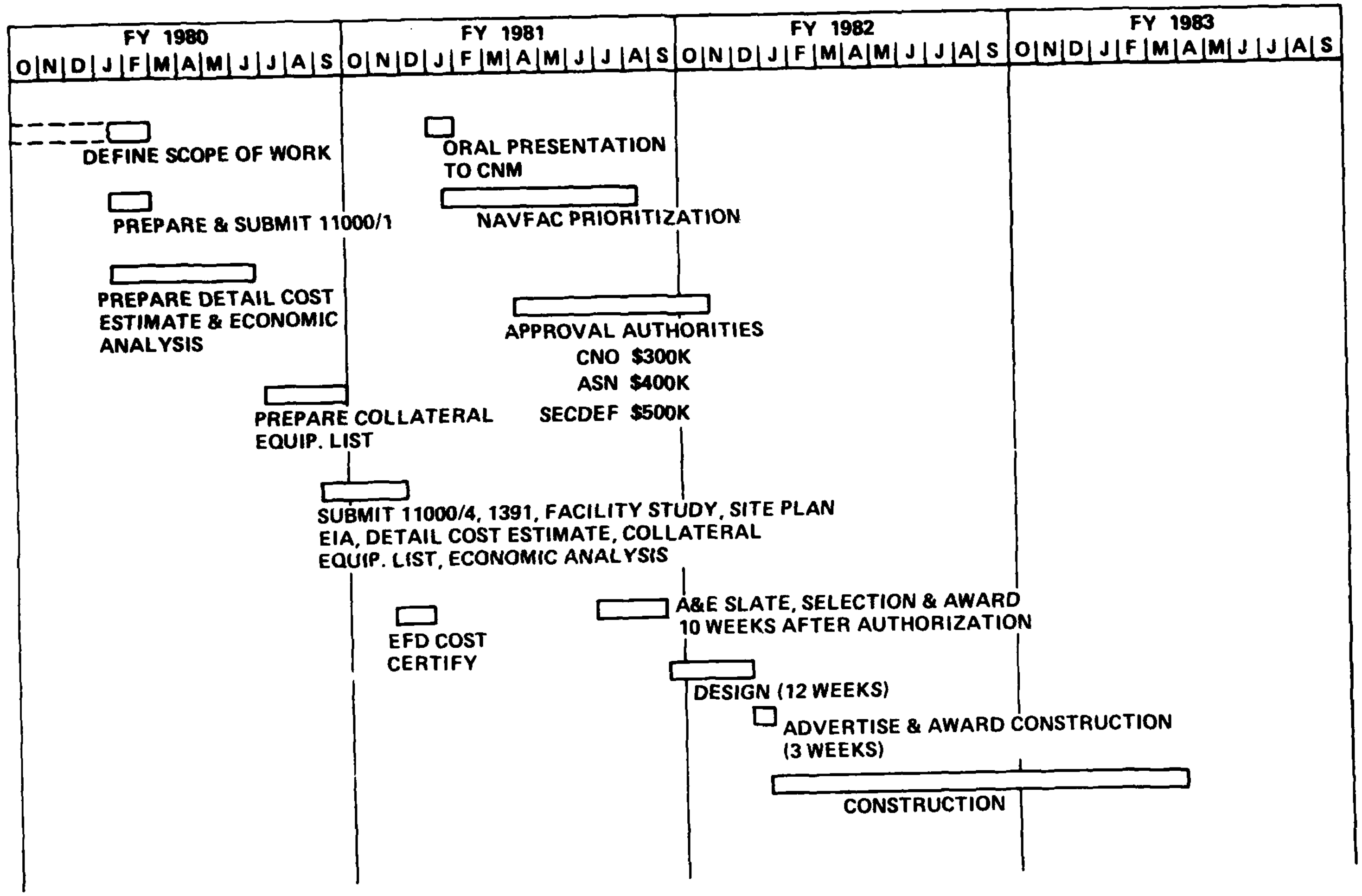

FIGURE 4 PROGRAM/BUDGET CYCLE: FY 81 EXIGENT MINOR MILCON PROGRAM

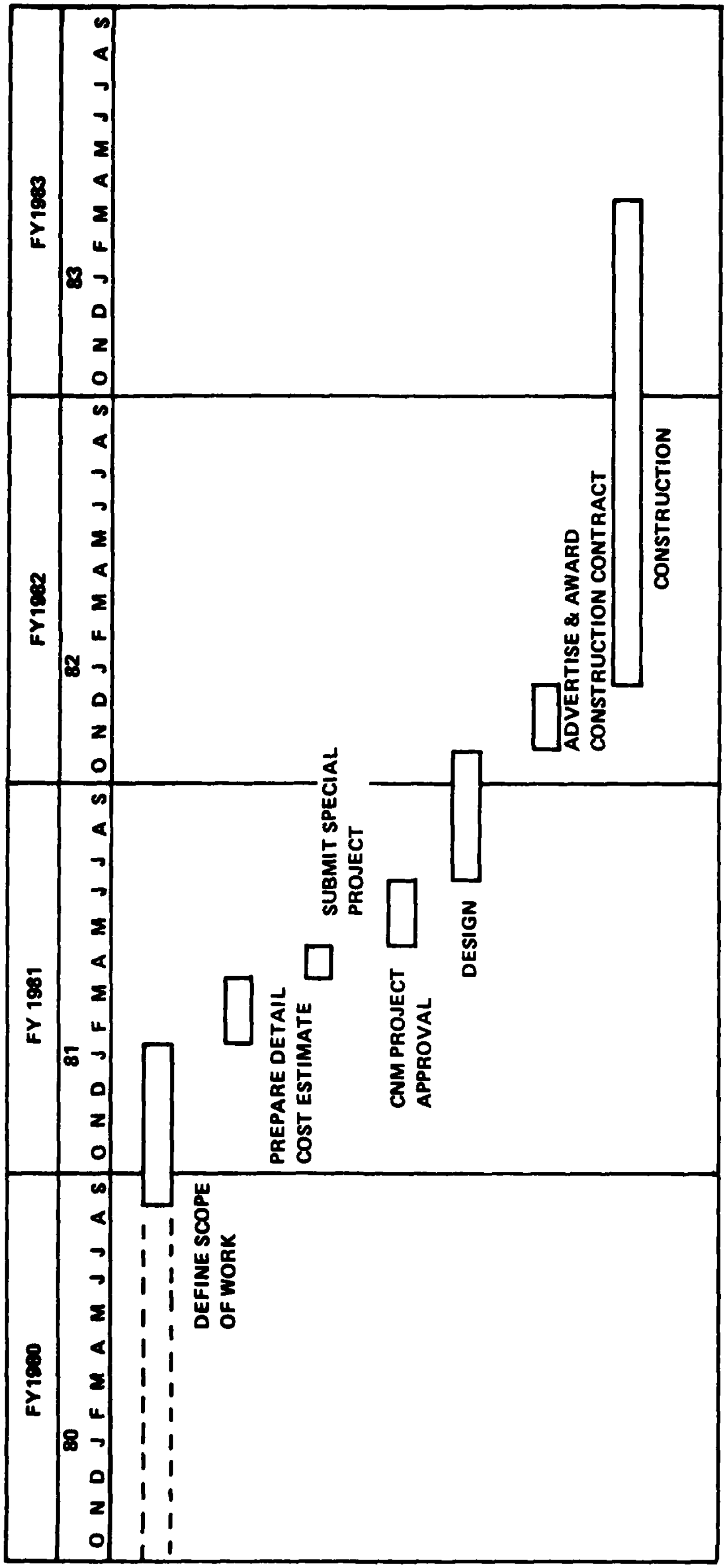

FIGURE 5 PROGRAM/BUDGET CYCLE : CLAIMENT FUNDED CONSTRUCTION PROGRAM

3.3.7 SESF Task Area Impact Discussion.

3.3.7.1 In order to illustrate the impact of MILCON requirements on the SESF development schedule, the MILCON Program/Budget Cycle information of Figures 2, 3, 4, and 5 was condensed and combined to generate the SESF planning alternatives chart of Figure 6.

3.3.7.2 REGULAR AND SLMM MILCON. Entry into the Regular/SLMM MILCON processing cycle in October 1979 would result in a construction completion date of approximately April 1984, as indicated in Figure 2. This date cannot be advanced due to the annual June/July CNO/NAVCOMPT approval check point and its associated processing lead time; the next initiation date occurred last October 1978.

3.3.7.3 MAJOR EMERGENCY CONSTRUCTION: Assuming appropriate approval for this construction alternative, then initiating a Major Emergency Construction program in February 1980 would have resulted in a projected construction completion date of approximately April 1984; even though this programming alternative results in an estimated four-month reduction in processing lead time, the CNO/NAVCOMPT approval checkpoint (and subsequent scheduling) remains the same. As shown by Option (2) under Major Emergency Construction in Figure 6, the programming could have been initiated as early as February/March 1979. This would have led to the completion of facility construction by approximately April 1983. However, this approach represented unacceptable technical risk since the SESF concept was not sufficiently defined at that time to warrant detailed construction planning submittal of approval requests.

3.3.7.4 EXIGENT MINOR MILCON. As illustrated in Figure 6, this alternative would allow the completion of construction by approximately April 1983 if the following conditions were met:

a. EMM authorization obtained

b. Construction costs were within $100K to $500K.

c. Conceptual design sufficiently detailed and approved to permit program initiation in January 1980.

3.3.7.5 CLAIMANT FUNDED: This option allows the shortest approval processing time and could lead to completion of construction as early as October 1982, as shown in Figure 6. However, its severest constraint is the $100K spending limitation; this effectively constrains the SESF to be installed within an existing building without requiring extensive modifications. Essentially any new construction would drive the cost over $100K. If, however, the facility could be so located within an existing structure, then the Claimant Funded programming lead time is such that detailed planning could have commenced in late FY80 with construction still being completed by April 1983.

SECTION 4. CONCLUSIONS

4.1 Two critical features of an acceptable shipboard security system are very low false alarm rates and reliable, low detection thresholds. Significant factors affecting these performance criteria are the locations and interface characteristics of shipboard installation scenarios and associated shipboard environments.

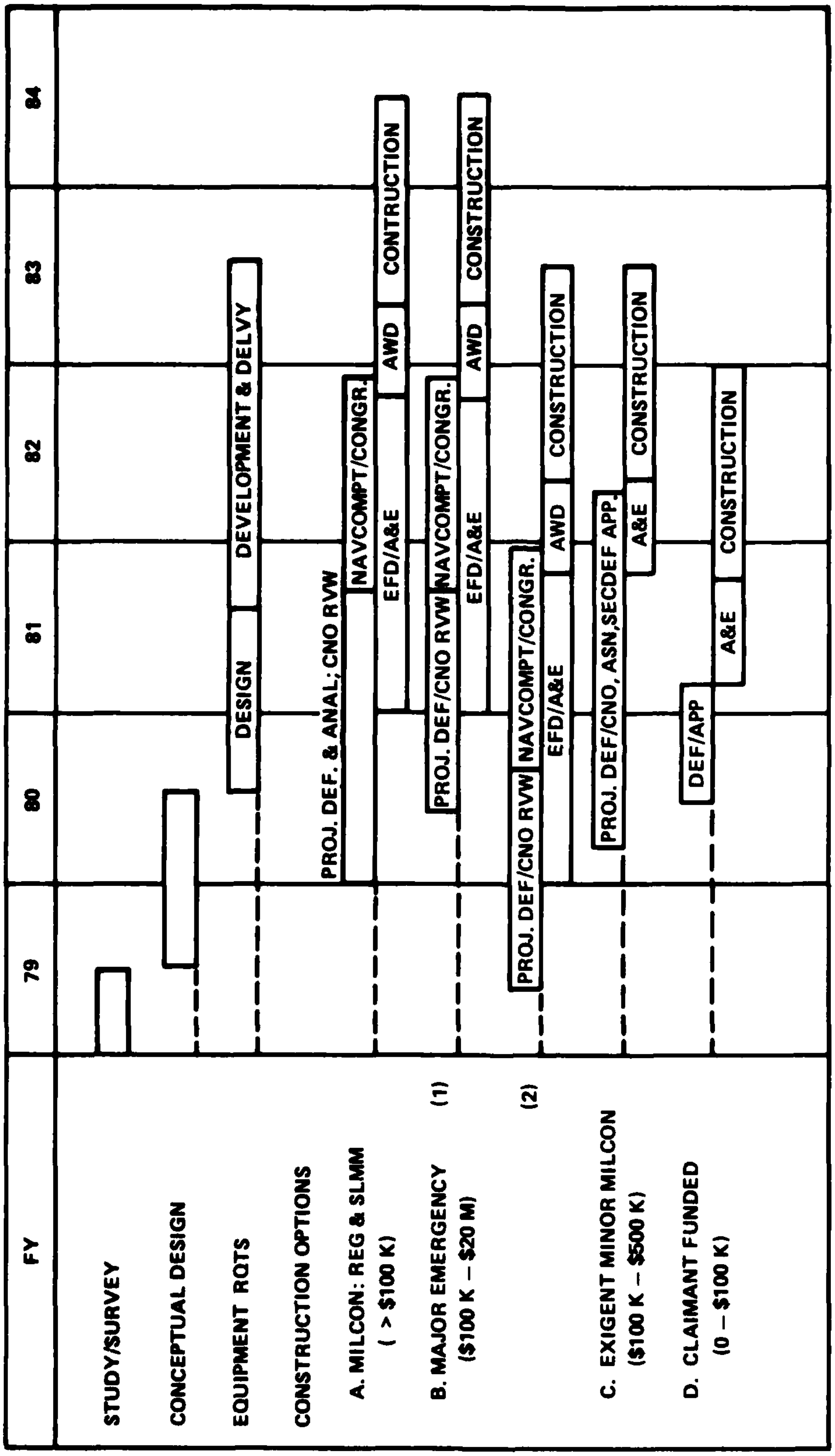

FIGURE 6 SHIPBOARD ENVIRONMENTAL SIMULATION FACILITY PLANNING ALTERNATIVES

Thus, it is of prime importance that a testing facility for shipboard security systems incorporate the technical and operational capabilities associated with the factors. (paragraph 3.1)

4.2 The most practical approach for developmental test and evaluation of shipboard nuclear weapons security systems is via a land-based environmental simulation laboratory or facility. (paragraph 1.5)

4.3 There is no existing facility which provides the technical and operational simulation capabilities desired for developmental test and evaluation of shipboard nuclear weapons security systems. (paragraph 3.2.3)

4.4 The technical capabilities desired of the SNWS test facility are: (paragraphs 2.1, 3.1.1, and 3.1.2).

4.4.1 The ability to simulate shipboard environments which affect the operability and reliability of security systems.

4.4.2 The ability to provide realistic shipboard compartment configurational features.

4.4.3 The ability to provide shipboard equipment interface characteristics which influence the operability and reliability of security systems.

4.5 The operational capabilities desired of the SNWS test facility are: (paragraphs 2.1 and 3.1.3)

4.5.1 The ability to test and evaluate the performance of security systems, including agressor/response force actions.

4.5.2 The ability to investigate the effects of personnel/ship/security system interfaces in relation to systems effectiveness.

4.5.3 The ability to support the development and assessment of security tactics and operational procedures.

4.6 The following physical characteristics are necessary to satisfy the desired capabilities of the facility:

4.6.1 Shipboard Environmental Conditions. (paragraph 3.1.1). Based on their relationship to the performance of security system equipments, six principal environment capabilities were identified for inclusion in the SESF. They are: vibration; acoustics; thermal effects; electromagnetic radiation; stray magnetic fields; and humidity. At present they are not sufficiently well-characterized to support the SESF detailed design; parametric criteria will be refined based on the results of a shipboard measurements program which will be conducted in FY80.

4.6.2 Shipboard Spaces. (paragraph 3.1.2). Eight generic shipboard areas were designated as being applicable to the SESF for simulation purposes, since some element of security system would be located in the areas. They are: nuclear magazines and adjacent spaces; small arms lockers; buffer zones/security stations; access trunks to nuclear magazines; weapons assembly and handling areas; nuclear weapons control stations; and security alarm switchboard locations.

4.6.3 Shipboard Interfaces. (paragraph 3.1.2). Interfaces involve equipments and characteristics of shipboard locations which could affect the performance of security systems. They are represented by compartment accesses, thermal effects, illumination, acoustics, vibration, penetration resistance and electrical/electronic interferences.

4.7 COMBINED ENVIRONMENT TEST FACILITY STUDY. (paragraph 3.2.4). A review of a prior study for facility with environmental testing capabilities similar to those desired for the SESF, but without corresponding compartment and interface characteristics, provided the following information:

4.7.1 Simultaneous simulation of multiple shipboard environments in a test facility is feasible.

4.7.2 Facility development costs are strongly influenced by the mass of the test compartments.

4.7.3 Environmental testing requirements constitute the dominant cost factor because of associated equipment costs.

4.7.4 A detailed analysis and design study should be performed prior to proceeding beyond the feasibility and general requirements definition phase.

4.8 MILITARY CONSTRUCTION PROGRAMMING.

4.8.1 The key funding threshold for Military Construction Programming is the $100K limit; in general, projects exceeding $100K in cost require considerably more processing time from project definition to start of construction. There are emergency and exigent programs that allow for some reduction in the processing time, but they are subject to stringent qualification criteria and high-level approval authority. Due to the extreme competition for available funds, only the highest priority construction projects are implemented via MILCON appropriations. However, in some instances it is possible to augment the congressionally imposed funding constraints by injecting project funds. In this case a construction program need only be qualified, authorized and approved; funding is provided by the project sponsor, rather than the MILCON appropriations budget.

4.8.2 The least costly method of developing the SESF appears to be the utilization of an existing building that is inherently suitable for housing the facility equipments. However, the specific requirements of such a building are beyond the scope of this study; a more detailed planning and design study is required to establish this type of facility requirements data.

SECTION 5 RECOMMENDATIONS

5.1 It is recommended that the development of a shipboard environmental simulation facility for the SNWS Program be continued via implementation of a follow-on conceptual design phase. This phase will develop detailed technical specifications and configurational arrangements for the proposed facility. It will also provide trade-off analyses of cost versus technical capabilities. (Note: Based on this recommendation, two contracts (N60921-80-C-0034 and N60921-80-C-0035) were awarded for developing a conceptual design for the SESF. Appendix A presents the statement of work for these contracts.)

5.2 It is recommended that the decision to continue development of the facility be reviewed after completion of the conceptual design phase. At that time, proposed technical capabilities and projected cost estimates should be assessed with respect to technical requirements and program funding constraints to determine the practicality of proceeding into the A & E pre-construction phase.

REFERENCES

1. Interface Standard for Shipboard Systems; Section 300 (8/1/78): Electric Power, Alternating Current (Metric), DoD-STD-1399 (Navy).

2. Interface Standard for Shipboard Systems, MIL-STD-1399B (Navy) (11/22/77).

3. Environmental Test Methods, MIL-STD-810C (3/10/75).

4. Electronic, Interior Communication and Navigation Equipment, Naval Ship & Shore: General Specification for, MIL-E-16400G (Navy) Amendment 1 (12/1/76).

5. Mechanical Vibration of Shipboard Equipment (Type I - Environmental & Type II - Internally Excited), MIL-STD-167-1 (Ships) (5/1/74).

6. Shock Tests, H. I. (High-Impact); Shipboard Machinery, Equipment & Systems; Requirements for, MIL-S-901C (Navy) (1/15/63).

7. Electromagnetic Interference Characteristics; Requirements for Equipment, MIL-STD-461A (7/3/73).

8. Electromagnetic Interference Characteristics; Measurement of, MIL-STD-462 (5/1/70):

9. Definitions of & Basic Requirements for Enclosures for Electric & Electronic equipment, MIL-STD-108E (8/4/66).

10. Shipboard Nuclear Weapons Security Program, Preliminary Survey of Environmental Data for, NSWC MP 79-131 of 4/15/79.

11. Climatic Extremes for Military Equipment, MIL-STD-810B, 1973.

12. Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment, MIL-HDBK-235, Parts 1, 2 and 3.

13. Preclusion of Ordnance Hazards in Electromagnetic Fields; General Requirements for, MIL-STD-1385 (Navy).

14. Navy Technical Facility Register, NAVMAT P-3999-1 (2 volumes) April 1973, Department of the Navy.

15. DARCOM Test Facilities Register, DARCOM-P-70-1 (May 1976); US Army Material Development and Readiness Command.

REFERENCES (Cont.)

16. AF Technical Facility Capability Key, AFSCP 80-3 (1 September 1967)

17. Technical Facilities Catalog (NASA) NHB 8800.5 (2 volumes)

18. Index of Environmental Test Equipment in Government Establishments, Shock & Vibration Information Center, Naval Research Laboratory, Third Edition, November 1967.

19. Final Report for Combined Environment Test Facility Study, Phase III, 4 June 1969, prepared by Huges Aircraft Co, Fullerton, CA for the Naval Electronics Laboratory Center under Contract N00123-69-C-0066

20. Facility Survey, Institute of Environmental Sciences, 1965 and 1966 Supplement.

21. A Free-Form Test Facility for Large Scale Structural Models of Ship Sections or Components, NSRDC Report No. 2979, March 1971.

22. Instrumentation Directorate Bulletin 74-1, Electromagnetic Interference Shielded Enclosure, Headquarters U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, October 1975.

23. AS-A013 355, Test and Evaluation Directorate Facilities and Capabilities, U.S. Army Missile Command, Redstone Arsenal, Alabama, March 1975

24. Army Materiel Test and Evaluation Directorate Facilities and Capabilities, U.S. Army White Sands Missile Range, New Mexico

25. Environmental Facilities, Pacific Missile Test Center, Point Mugu, California.

26. Electromagnetic Compatibility Testing, Pacific Missile Test Center, Point Mugu, California.

Appendix A

SESF CONCEPTUAL DESIGN STATEMENT OF WORK

A.1 INTRODUCTION

There is no existing Shipboard Environmental Simulation Facility (SESF) that includes the operational and environmental testing capabilities and configuration flexibilities required to assess the performance of shipboard nuclear weapon security systems. In the context of this statement of work a security system comprises not only hardware, but also the personnel functions and the operational procedures associated with the deployment of security equipment. Correspondingly, the performance of a security system involves the effective interrelated utilization of all three of these system elements. The objective of this contract is to develop a conceptual design for a simulation facility to meet the testing requirements of the Shipboard Nuclear Weapons Security Program. The facility shall meet the following general functional objectives:

PRIMARY: TECHNICAL FUNCTIONAL OBJECTIVE

A.1.1 Provide test and evaluation capabilities for shipboard security systems.

SECONDARY: OPERATIONAL FUNCTIONAL OBJECTIVES

A.1.2 Provide the capability to perform realistic intruder penetration trials.

A.1.3 Provide the capability to develop and validate security system operational procedures.

A.1.4 SPECIFIC CAPABILITIES TO MEET THE TECHNICAL FUNCTION OBJECTIVE.

A.1.4.1 Provide a means of testing security systems incorporating sensors which could operate on a wide range of sensing mechanisms.

A.1.4.2 Be capable of simulating shipboard environments which are likely to affect the operation of a security system.

A.1.4.3 Provide a means to measure the performance parameters of security systems so the relative merit of competing security concepts can be determined.

A.1.4.4 Provide a means to simulate the electrical and mechanical interfaces of the security systems with other shipboard systems.

A.1.5 SPECIFIC CAPABILITIES TO MEET OPERATIONAL FUNCTIONAL OBJECTIVES.

A.1.5.1 Provide the human to security system shipboard interfaces.

A.1.5.2 Provide a means to perform realistic aggressor penetration trials and aggressor/response force detection and engagement exercises.

A.1.5.3 Provide supporting data for computer modeling of security systems.

A.1.5.4 Provide support for the development and the evaluation of the security system operational tactics, procedures and technical documentation.

A.1.6 The conceptual design shall include a dimensioned site layout showing the relationships of the various shipboard spaces, the ancillary and environmental testing equipment, and the structural enclosure. The information shall be presented in sufficient detail for subsequent release of the conceptual design package for a follow-on A&E contract.

A.2 FACILITY CAPABILITIES AND REQUIREMENTS

A.2.1 The facility shall provide the representative shipboard spaces, equipments, and environments to meet the general function objectives given in paragraphs A.1.1.1 - A.1.1.3. These configurational, interface and operational characteristics of the facility are described in the following paragraphs.

A.2.1.1 REPRESENTATIVE SHIP SPACES, EQUIPMENT AND INTERFACES.

A.2.1.1.1 Interior Spaces.

a. Compartments: The simulation facility shall include, at a minimum, the ability to simulate eight different types of shipboard compartments which are representative of nine classes of ships. These spaces are presented in matrix form in Table A. Specific shipboard compartments need not be duplicated. Partial or scale-sized simulations are allowable, and encouraged, if technically justified. Original approaches or techniques that will reduce the total number of compartment simulations without compromising SNWS program requirements are encouraged as long as they are technically justified.

b. Access modes: The configurational simulations shall provide representative accesses (e.g., scuttles, hatches, doors, elevator panels) to nuclear magazines. These accesses shall be designed for repair or replacement in the event they are damaged during penetration trials.

c. Interface characteristics: The shipboard compartments of paragraph A.2.1.1.1a shall be equipped to simulate those shipboard equipment to security system interfaces which are likely to affect the performance of security systems. Consideration shall be given, but not limited to, the following items:

1. Air flows (convection currents, vibrations and noise emanating from air conditioning, heating and ventilation ducts and outlets).

2. Piping (steam or cooling water service through compartments which may cause a thermal effect on the security system).

3. Illumination (fluorescent and incandescent lighting).

4. Communication equipment (EMI, acoustic or static interference; also security systems may involve communications links between security stations).

5. Thermal background/emissivity (possible hotspots or coldspots which affect the security system).

6. Bulkheads (material composition affecting thermal characteristics and penetration resistance).

7. Ancillary equipment (cranes, forklifts, handling dollies, etc.).

8. Ship-to-shore power transfer.

9. Steady state voltage and frequency variations (MIL-E-16400G).

10. Transient voltage variations (MIL-E-16400G).

11. Spike voltage variations (MIL-E-16400G).

12. Power interruption (MIL-E-16400G).

13. Stray magnetic fields (60 Hz to 400 Hz; induced by ships power or electric motors).

14. Aircraft launch and retrieval - (noise and vibration effects).

d. The shipboard compartments shall serve as the environmental test cells. The ability to perform operational and environmental tests concurrently is a desired, but not necessarily required, feature in the realistic simulation of operational scenarios for security system tests. All compartments need not incorporate environmental testing capabilities and interface functions. Some compartments may be only physical mock-ups. Those compartments selected for environmental testing capabilities and interface functions shall be isolated as much as possible from sources which might introduce uncontrolled acoustics, vibration, heat, light, etc. That is, the only environmental effects present are to be induced by the conditioning or interface equipment under controlled conditions.

A.2.1.1.2 Weather Deck Equipment and Areas.

a. Exterior ship features shall also be provided in the simulation facility. Weather deck areas not only provide initial off-board access routes to nuclear magazines, but also provide direct access to canister-stored weapons (integral magazines and launchers). Specific areas of interest include launchers (e.g., ASROC, TOMAHAWK), ship sides, brows, and helicopter pads or landing decks. Security system performance in these areas is affected by weather conditions, deck arrangements, and operation of shipboard equipment. Consideration shall be given to providing weather deck environmental testing capability by exposing this area to the natural climate of the test site.

b. The contractor is not constrained to these exterior ship features. As in the case of interior spaces, specific shipboard areas need not be exactly duplicated. Partial or scaled simulations are allowable and encouraged provided they are technically justified by the contractor.

A.2.1.1.3 Reconfiguration Options.

a. To reduce both the working area of the facility and the number of simulated shipboard spaces, reconfiguration of spaces within the facility shall be considered. Such reconfiguration options may be accomplished by movable bulkheads/partitions within the facility. The options shall be based on optimally representing the spectrum of shipboard spaces and areas given in Table A and in A.2.1.1.1 and A.2.1.1.2.

b. The configurational options represent an extended feature of the compartment requirements described in paragraph A.2.1.1. Consequently, it is highly desirable that the implementation of this additional feature not compromise the basic capabilities of the test cells. However, cost and technical trade-offs in this area will be considered based on the merits of the proposed alternatives.

A.2.1.2 SHIPBOARD ENVIRONMENTS.

A.2.1.2.1 The simulation facility shall be capable of, as a minimum, simulating the following shipboard environments:

a. electromagnetic radiation
b. vibration
c. acoustics
d. temperature
e. humidity

A.2.1.2.2 Other shipboard environments (as per MIL-E-16400G) should be considered and a rationale given for their inclusion in, or exclusion from the capabilities of the simulation facility. This rationale should focus on costs versus risks of not adequately testing the security system. Novel or original thinking in ways to provide environmental testing capabilities - such as the inclusion of a weather deck area where components could be exposed to the natural elements - is encouraged. The ability to use existing test facilities to cover testing in areas not covered by the simulation facility should be addressed in the rationale. Examples of other shipboard environments which shall be considered for the facility are:

a. ship motion
b. icing
c. solar radiation
d. rain
e. wind
f. salt fog
g. shock
h. gun blast
i. missile exhaust
j. nuclear air blast

k. barometric pressure
l. ionizing radiation
m. atmospheric pollutants

A.2.1.2.3 The expected worst case levels for the five mandatory environments are presented in Table B. The simulation facility need not be capable of testing to these worst case levels if sufficient justification for reduced capabilities is developed. The justification should include cost benefits derived from limiting worst case levels and the ability to test to worst case levels in an existing facility. In no case should the testing capability in the five mandatory environments be less than the normal shipboard operating levels given in Table A.

A.2.1.2.4 The simulation facility shall be capable of testing combinations of the five mandatory environments simultaneously. A rationale shall be developed for those combinations of environments which are to be included in the capabilities of the simulation facility. This rationale should be based on which combinations of environments are likely to have an adverse affect on security sensor false alarm rates, sensitivities, and threshold levels. The ability to test for a single environment shall be retained.

A.2.1.3 CAPABILITIES FOR SIMULATED OPERATIONAL SCENARIOS.

The integrated operation of the facility features (spaces, equipment, interfaces, and environmental simulation) shall provide the capability for realistically simulating operational scenarios applicable to the installation, operation and verification of shipboard nuclear weapon security systems. The facility shall be capable of supporting the following activities:

A.2.1.3.1 Investigation of Security System Performance. This includes aggressor/response force actions with realistic penetration trials. Since penetration attempts are not limited to designated entryways, replaceable panels/bulkheads shall be provided for forced entry intrusion methods. Also a means to monitor, assess and referee the aggressor/response force activities shall be provided.

A.2.1.3.2 Investigation of Integration Requirements. The simulation facility will be used to determine the ability of shipboard security system to interface with security systems of other ships and of shore installations.

A.2.1.3.3 Investigation of Security Procedures. The development of security procedures requires knowledge of the functional relationships between security personnel and security equipment. The facility will be a test bed to obtain this knowledge.

A.2.1.3.4 Investigation of Personnel/Ship/Security System Interfaces. The operational effectiveness of security systems is strongly influenced by interactions with personnel and ship's equipment. These interfaces are described in paragraphs A.2.1.1.1 and A.2.1.1.2. To realistically investigate security system performance, these interfaces must be functionally interrelated similar to shipboard conditions.

A.2.1.4 It is not mandatory that each test cell or test unit incorporate both technical capabilities (paragraph A.2.1.1 and A.2.1.2) and operational capabilities

(paragraph A.2.1.3). Accordingly, the contractor shall address the advantages and disadvantages of both separating and combining the dynamic-oriented environmental/configurational features and the more static-oriented scenario/operational dependent capabilities. The contractor shall present a recommended course of action for providing these capabilities; the supporting rationale shall include, but not be limited to, discussions and trade-offs involving cost, technical validity and spatial requirements.

A.2.2 SITE REQUIREMENTS.

A.2.2.1 Location Options.

A.2.2.1.1 To reduce construction costs and to advance the availability date to the facility, the use of an existing building to house the facility would be desirable. However, new construction (or a combiation of new construction and the use of existing buildings) shall also be considered. A cost comparison shall be presented to support whichever site location and construction option is selected. The contractor shall present the site selection review as part of the Preliminary Report 60 days after contract initiation.

A.2.2.1.2 Candidate locations and existing structures for the facility are listed below:

a. Building 405, NSWC: There is a rooftop area about 200 ft L and x 45 ft W that is available for the facility. Utilization of this area would require erecting sides and a roof for the new facility, plus the existing roof would need to be decked over. The present roof is about 2 ft thick reinforced concrete, but the load-bearing capabilities are unknown.

b. Building 405, NSWC: A second option available at the Building 405 site involves expansion of a front section (available length is up to about 200 ft of the building by removing portions of walls and the roof, plus some foundation work after excavating to increase the available width for the facility.

c. Several buildings located at NASA, Wallops Island, VA are potential candidates to house the simulation facility. Specific structures will be identified at contract award if they are to be considered as site locations for the conceptual design task.

A.2.2.2 Instrumentation.

The instrumentation system shall include equipment for signal conditioning, display, readout and data reduction and analysis processes. These functions shall be centralized and performed in the immediate vicinity of the centralized control station for the facility. It is anticipated that the intrusion sensor mechanisms of Table C will be representative of the types of equipment that will be tested in the facility. The instrumentation system must be capable of measuring and recording the performance parameters of such security systems.

A.2.2.3 Control Requirements.

The conceptual design shall include control system requirements for all facility operations. The control functions shall be performed from a remote, centralized location. They will be programmable such that multiple combinations of test scenarios up to 120 hours in duration can be inputed and automatically implemented. Feedback control loops are necessary for maintaining the prescribed environmental test condition. Manual override capabilities shall be incorporated into a control circuit. Emphasis shall be placed on the use of basic hardware items (such as a mini-computer for control functions and data reduction and analysis) which can serve multiple functions via hardware peripherals or software.

A.2.2.4 Facility Support Equipment and Utilities.

The conceptual design shall specify the support equipment and utilities necessary for complete operation of the facility. Examples of the environmental simulation laboratory and site functional requirements include:

a. heating/cooling
b. power
c. computer modeling interface
d. overhead crane
e. lighting

A.2.2.5 Test Setup and Preparation Area.

The conceptual design shall incorporate the capability for an area of approximately 400 ft^2 for laboratory work on security system equipment in support of facility test and evaluation experiments. The specification and spacial arrangement of the test support equipment and laboratory furniture will be performed by the Government.

A.2.2.6 Operations Support.

A.2.2.6.1 The conceptual design shall include staffing requirements for facility operation and maintenance, exclusive of specialized technical staff requirements in support of equipment undergoing tests. The staffing estimate shall include disciplines such as management, engineering, technician, and maintenance personnel. Cost information shall be presented on a per annum format for each staff member.

A.2.2.6.2 The conceptual design shall include those areas (such as office and engineering support spaces) that are required to support all operational and maintenance functions of the facility. Cost information shall be presented for each completely outfitted and functional area on an individual basis.

A.3 COST ESTIMATES AND RISK ASSESSMENT ANALYSIS

A.3.1 For the purpose of cost versus capability trade-offs, cost estimates shall be presented for each capability described in the appropriate subparagraph of Section A.2. It is of particular interest that the data format shall clearly illustrate the relationship of incremental changes in technical capabilities (paragraphs A.2.1.1, A.2.1.2 and all individual subparagraphs) and in operational scenario capabilities (paragraph A.2.1.3 and all subparagraphs) to corresponding changes in costs.

A.3.2 A risk assessment analysis shall be prepared which identifies any areas of high technical risk. The analysis shall address risk areas at the lowest applicable level of discrete task or facility functions, and shall include risk/cost tradeoffs as appropriate.

TABLE A. SESF REPRESENTATIVE COMPARTMENT SIMULATIONS

	SHIP CLASS								
SHIPBOARD SPACE *	AE 26	AS 36	CG 27	CGN 38	CV 63	DD963	FF 1052	LPD 4	SSN 637
Nuclear Weapons Magazines	1	1	1	2	2	1	1	1	1
Spaces Adjacent to Nuclear Magazines	0	0	2	8	2	1	2	2	0
Buffer Zones/ Security Stations	0	1	0	0	2	1	0	1	0
Access Trunks to Nuclear Magazines	2	2	0	0	2	0	0	1	0
Assembly/Checkout Areas	0	1	1	0	0	0	0	0	0
Nuclear Weapons Control Stations	0	0	1	0	0	1	0	0	0
Security Alarm Switchboard Locations	1	0	0	0	1	1	0	0	0
Small Arms Lockers	1	0	1	2	0	1	2	1	0

*NOTE: The number in each matrix element represents the number of specific types of shipboard spaces, for the given ship class, that are candidates for the environmental simulation facility.

TABLE B. SHIPBOARD ENVIRONMENTAL LEVELS

ENVIRONMENT	NORMAL OPERATING LEVEL	WORST CASE LEVEL
Electromagnetic Radiation	30 db down from worst case levels Shipboard measurement program could change this level	15 KHz to 40 GHz Maximum energy levels are specified in MIL-HDBK-235 (Navy for shipboard hangar and weather deck areas)
Vibration	1-100 Hz with 2-20 Hz predominant .3 g peak amplitude	2-100 Hz with 2-20 Hz predominant
Acoustic	22Hz -20 KHz 117 db shipboard measurements program could change this level and frequency range	165 db 45 Hz -20KHz Near aircraft and rocket motors
Temperature	$30^{o}F$ to $+125^{o}F$	$-40^{o}F$ to $+160^{o}F$
Humidity	20% to saturation at $95^{o}F$	20% to saturation at $95^{o}F$

TABLE C. TYPICAL SECURITY SYSTEM SENSOR TYPES

PHENOMENA	SENSORS		BAND
Motion	Active Doppler	Sonic	100 - 5 KHz
		Ultrasonic	10K - 50 KHz
		Microwave	MHz --- 20 GHz
Vibration (Cutting)	Taut Wire		Below 20 Hz
(Cutting)	Barrier/Surface (Bulkhead) Sensor		10 - 50 KHz
Noise	Passive Audio (Sonic)		Up to 20 KHz
Heat Source	Infrared		3 - 5μm 8 - 12μm
Visual Surveillance	Closed Circuit TV		0.4 - 0.7μm (Visible Light)
Electrical Continuity	Switches, Metallic Tape		DC/AC
Break Beam	IR or Visible Light Source Beam & Receiver		Visible or IR

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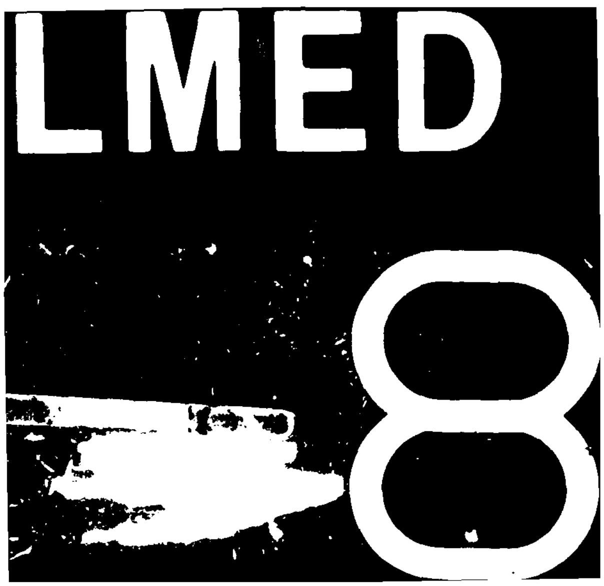
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